SCIENCE

New Series
Vol. LXVIII, No. 1753

Friday, August 3, 1928

Annual Subscription, $6.00
Single Copies, 15 Cts.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal.

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

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SCIENCE AND THE PRESS

ONE of the features at the Nashville meeting of the association was a symposium on the distribution of scientific knowledge, which was held on Wednesday, December 28, under the chairmanship of the news manager.

The object of the symposium was to bring about closer cooperation between those who are engaged in scientific work and those who are engaged in furnishing the general public with information through books, magazines and newspapers.

The morning session was devoted to an exposition of the situation in regard to popular books on scientific subjects, while the afternoon session was concerned with science in newspapers and popular magazines.

In opening the morning session the chairman said:

"One of the most impressive lessons to be learned from history is that wars exert a stimulating and at the same time a disturbing influence on the affairs of men, and especially is this true of revolutions.

"Following a long period of incessant strife, the French revolution of 1789 had an immediate reflection in England in the announcement by many of the foremost writers of the day that a new and golden age had opened for mankind. Coleridge, for instance, proposed a scheme for an ideal community which was to form a model settlement conducted on strictly communistic principles on the banks of the Susquehanna. Southey, Shelley and Byron held much the same ideas, and so did Wordsworth.

"The writings of Bentham, Locke, Adam Smith and others of the so-called philosophical radicals in the *Edinburgh Review* were typical of that time.

"No one at all familiar with English literature can fail to see in the outpourings following the French revolution an extraordinary similarity to the effusions in our own American press following the late war and the Russian revolution of 1917.

"In England this disturbed epoch gradually gave way, beginning in the early thirties, to a new era marked by a return to the old fundamental principles of society, but especially characterized by a gradual increase in the power of literature and of journalism. With the return of social stability there arose an increased interest in all things cultural and intellectual, including science.

"The increased power of the press stimulated this interest by bringing facts and ideas before a very

large number of people with a latent, but hitherto undeveloped, desire for this sort of information.

"The enormous advance in all lines of science which took place in the first half of the nineteenth century has been attributed to many causes, for instance, in zoology to the development of the microscope and other accessories. But the real cause was the immense intellectual curiosity and interest aroused through extensive publication of scientific facts and theories by commercial houses. Science had become democratized. Such journals as the *Illustrated London News* and the London *Times* created a market for authoritative books, and these books were extensively reviewed and criticized in the journals. The books and the journals each helped the other, and science reaped the benefit.

"In this country we are now well on the road to recovery from the social discords arising from the late war and the Russian revolution. We are just entering the phase which in England produced the great men of the Victorian epoch.

"Why were these men great? Because they were very widely known. They were widely known because their ideas through an active and interested press were laid before the people as a whole and subjected to the cold logic of those not biased by too great an application to detail.

"Let science and the press join forces and in the coming years prove that in America we can do what was done in England and in Europe one hundred years ago."

The chairman then called upon Dr. W. J. Humphreys, of the U. S. Weather Bureau, who spoke on the attitude of the research worker toward the press.

Mr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry,* had been asked to speak upon publicity for science. He was unable to attend the meeting, but furnished the following contribution, which was read by the chairman:

Publicity for Science

It is now twenty-two years since Robert Kennedy Duncan gave us "The Chemistry of Commerce," one of the first really serious efforts to create among people generally an appreciation of the work of science and to gain thereby the adequate support which research must have for its proper development. Duncan was criticized by his fellows, who did not appreciate his vision and who somehow felt that any effort to humanize or popularize the science was necessarily accompanied by a lowering of our scientific level. Indeed, that feeling has not yet disappeared from sight, and while chemistry perhaps more than any other science has shown how to turn to account the popular interest created in its work, the other sciences have been less fortunate and even recent attempts to appeal to the interests of the non-technical public have been subject to some criticism.

We have in America but few great musicians and great artists, and yet art and music thrive because millions among our inhabitants have a keen appreciation for them. Is it not logical to expect, therefore, a comparable interest in science if we can but give the intelligent laity and through them the people at large some idea as to what it is all about? It is recognized that the task is difficult, and that the difficulty is greater in some fields than in others. However much we believe in fundamental research, it is difficult to arouse interest in it at the start and the appeal must be made with reference to accomplishments in applied science. The business man, indeed the professional man, prefers to have you begin with something with which he is familiar—the milk bottle, a cake of soap, a mirror, his automobile—and then explain his debt to science, carrying him back over a route the reverse of that by which the thing he utilizes has come.

The principal difficulty has not been with the public. It has been with the scientists themselves. In our experience we once talked with a brilliant research man whose chief had once sent to him a reporter interested in learning what his work was about and how it appealed to the public. The young man could see no reason why he should be even courteous to the reporter, for he cared not whether the public knew of his work or not. He was laboring in a well-endowed institution. He was not dependent upon popular support, and it took some argument to persuade him that others not so well off could scarcely fail to receive greater sympathy for their work and indeed perhaps financial support for their work if his story could be added to the hundreds of others of what research in science means to the individual. Scientists have been accused, and with some justice, of inadequate preparation for writing and for speaking, and demonstrations come across the desk of every editor and are given at every scientific meeting. Some realize this and hesitate to write for popular consumption, but that does not excuse them from making an earnest effort to cooperate with those who endeavor to interpret their results for the lay and popular press.

Without wishing to set up the American Chemical Society as an ideal in work of this type, I do wish to refer to its experience, for I am most familiar with it. Some ten years ago, sensing the growing interest in the achievements of chemistry and finding on every hand examples of sensational newspaper accounts, because authentic data could not readily be secured by reporters, the society set up its own news service for the special purpose of interpreting the work of chem-

istry to the newspapers of the country. From the beginning the press received this offer of cooperation with open arms. It is true that even yet an occasional headline disturbs the pure scientist, but these things are trivial when considered in connection with the enormous gains made in obtaining intelligent and sympathetic public interest. This service has grown into a national and indeed an international institution. Its cooperation is sought by the greatest news service of the world. Its material is freely used by all grades of the press from the great metropolitan dailies downwards and includes magazines of recognized standing. The society spends some $8,800 per year upon this work and uses the technical articles appearing in its publications as the basis for its releases. To this are added special interviews and announcements, papers presented at its sectional, regional and semiannual meetings, quotations from its editorials, and such other material as is believed to have publicity appeal, evaluated by a competent newspaper man of experience who acts as managing editor under the director of the news service. In this, achievements in foreign lands are not neglected. The effort is to supply authentic information of the advance of the science wherever that advance is made, but with special reference to the activities of American chemists.

The results have been most satisfactory, whether measured by the actual space accorded these releases in the American press, or by the results which have come in substantial support of research work. Indeed, so large a number of clippings are now obtainable that their purchase has been discontinued because of excessive expense.

The relation of the journal for which I am responsible to this work is very direct, since *Industrial and Engineering Chemistry* is the journal of the society which endeavors to serve the technologists, the business men, the chemical executives. With its foreign correspondents, its contacts with seventy-four local sections of the society and eighteen special divisions, there is created a constant flow of material which only needs newspaper interpretation to make it useful. Articles in the journal are not selected in any case with respect to such publicity, but when once selected for their scientific merit, they are carefully considered with respect to whatever news value they may carry. It is gratifying to find that the journal itself makes an appeal to an increasing number of non-chemical readers who have been interested by the various efforts for the popularization of science, including the prize essay contest of the American Chemical Society, which has been made possible by the generosity of Mr. and Mrs. Francis P. Garvan, and who desire stronger meat and turn to the Journal and there find data often applicable to their own work. Occasionally, though less frequently than we should wish, articles can be accepted which are worthy of publication according to our standards and at the same time make a direct appeal to the business and professional man, and the avidity with which such numbers are read and the demand for single copies of the journals carrying such articles give another indication of the success with which publicity for chemistry is being conducted.

Let us say again that the problem is no longer that of creating public interest in what we offer. The problem is that of teaching the scientist to appreciate news value and of persuading him to take the public into his confidence.

At the conclusion of Mr. Howe's address, the chairman called upon Mr. Edward M. Crane, the president of the D. Van Nostrand Company, New York, who presented the following paper:

Science and the Publisher of Books

There are a multitude of reasons for the energetic progress of science. The representatives of each branch can put forward logical and demonstrable advances which have led to increasing interest in their specialties. Biologists point to the development of the microscope; chemists to the increasing force exerted by chemistry in industry; physicists and researchers in the electrical arts to the radio and to a hundred other accessories that work for the benefit of mankind and which have stimulated a public interest in their scientific source, but to me, a publisher of books, and largely of books devoted to the natural and humanistic sciences, a great part of this advance has been due to the part played by books in breaking down the wall that previously existed between science and the masses. Books and press articles have brought science to the people and the advances of recent years have caught and held their imagination, creating a vast and eager acreage that may be tilled in the interest of science. New science and literature have been interdependent since the dawn of civilized man, and perhaps few realize how closely their histories have paralleled each other.

The earliest written records of which we have definite knowledge are the slabs and cylinders of hardened clay on which the Hittites and Assyrians and other ancient nations etched crude messages with a kind of iron stylus. Later came the practice of decorating buildings with a story of contemporary events, a practice that lead Macaulay to aptly remark, "An Assyrian who published a bridge and four walls in honor of his emperor."

And these early races did not confine themselves solely to pottery slabs, but with a multiplicity of

patience utilized blocks of stone and tablets of bronze and lead and precious metals. The archives of early Rome and Alba Longa were veritable treasure houses.

As the beginnings of the sciences are sought in the slow and unconscious observation of natural events by primitive races, so their earliest records commence with the dawn of literature.

The Egyptians were the inventors of an improvement which revolutionized the art of writing, the effects of which are apparent to the present day. They first utilized the long leaves of the papyrus as a medium for the exchange of messages and were responsible for the development of ink. The obvious advantages of papyrus caused its use to spread throughout the western world and the libraries of Greece and Rome of the time of Julius Caesar were largely composed of papyrus rolls incased in metal canisters. It was by such crude vehicles that the observations of the early astronomers, philosophers, mathematicians and alchemists have been preserved for us. The writings of Archimedes, of Aristotle, of Euclid, of Hipparchus, and of a few other great thinkers of the dawn era of science remained for centuries in the libraries of Rome, Greece and Egypt, inscribed in rudimentary books available only to an educated few, but having an appreciable effect on the thought of the masses.

Manuscripts of uncalculable value were demolished by the barbarians who, to prevent the spread of Roman culture, persistently destroyed the storehouses of Roman knowledge. Science no less than literature suffered from their depredations.

During the dark ages and the middle ages the advance of science was comparatively slow. In literature it was a period of the preservation of early records. Cloistered monks in musty monasteries deciphered and retranscribed early writings upon illuminated books of parchment. Duplication was as laborious and slow as the preparation of the original. It took years to properly make a book, many a monk devoting his entire life to the preparation of a single volume. As a consequence, knowledge was largely restricted to the monasteries, where it was a labor of religion to develop libraries of works on theology, science and literature. Probably no era since the dawn of civilization has seen such an uneducated lot of ordinary citizenry as the men and women of those times. It was an age of arrested progression and restricted education.

In 1423 and 1448, depending upon whether you credit the invention of printing to Gutenberg, the German, or to Coster, the Hollander, there occurred the momentous discovery which released learning from the monasteries and brought it to the people. Printing made duplication inexpensive and the dissemination of knowledge possible. As literature developed so science developed and for much the same reasons. The observation and reflections of their ancestors were made available in inquiring minds and the age of experiment and investigation began. It is more than a coincidence that the two centuries immediately following the introduction of printing and book-making as a commercial factor saw an unparalleled advance of scientific development. Francis Bacon, Galileo, Kepler, Boyle, Tycho Brahe and others read books, studied, investigated, recorded their discoveries for the benefit of posterity and erected the foundations on which modern science is built.

Until the present century the writings of scientists and philosophers were largely intelligible to scholars only. A barrier of technical phraseology was set about the world of science that effectively prevented public entrance. Even the widespread interest in the pronouncements of Darwin and Huxley failed to produce any lasting books of popular interest, although the publication of their own books through commercial houses gave them a wider sale than any previous works on science.

So to the commencement of the present era, centuries of scientific and literary progress pass in review, displaying a constant and harmonious progression, arrested only during the dark days preceding the renaissance of study that came in the fifteenth century. Science has emerged from a buried past, hand in hand with books. It grows, expands, and now arrives at the latest phase of its growth.

Popularization, simplification, democratization—call it what you will—this latest phase, the bringing of scientific knowledge to the masses is of far-reaching importance to the world. To a scientific publisher it is perhaps the most remarkable publishing development since the war.

I have before me some significant figures relating to book production in the United States which reveal the scope of this development. In 1920 there were 182 books on pure science published in this country, 259 technical books and 611 books on the humanistic sciences, such as psychology, philosophy and sociology. In 1921 there were 227 scientific books, 331 technical books and 618 humanistic science books. There is no need to give detailed figures for the intervening years in which the number of books constantly progressed to a point where in 1926 there were 312 scientific books, 403 technical books and 888 books on humanistic science. This is a total increase of over 50 per cent. as compared with the total increase in general book production of slightly less than 20 per cent. There were about one thousand five hundred more books published in 1926 than in 1920, nearly six hundred of which were devoted to the natural and

humanistic sciences. In 1815 a rare Elwood Hendrick attempted to interpret science to the people. To-day we have a host of Thomsons, Slossons, Durants, Dorseys. We have a "Story of Philosophy" that approaches 200,000 copies in sales. We have an "Outline of Science" that has sold 100,000 copies, a "Why We Behave Like Human Beings," that has been a best seller for three years, a "Library of Modern Sciences" that popularizes the work of important researches and carries it to the non-technically educated layman, a wealth of excellent volumes that appear on the shelves of bookstores, besides books of fiction and biography. Thousands of school children are contributing to the national prize essay contest on chemistry.

It is a sound condition. Science is dependent upon popular subscription for a large measure of its sustenance. The Rockefeller Foundation, the Mellon Institute, the Chemical Foundation and similar organizations are supported by private capital. Our universities depend upon friendly legislatures or private endowment. Anything that can stimulate capital and increase the friendliness of governing bodies is of infinite value to the progress of science. That the popularization of science, the publication of sound books by accomplished technicians and their reading by uninitiated laymen will advance the cause of science is an argument that I hope will appeal to every scientist present. The wall has been broken, a friendly entente established between the scientists and the public.

This public wants books by acknowledged leaders of thought. They are wary of pseudo-scientists, hack writers that masquerade as authorities, an evil that will grow if leaders neglect the popular field or feel that it is demeaning to write to the common level of intelligence. Nor does this new movement necessitate a relaxation of effort in the production of profound books. As the public is educated by popular books to appreciate more rigorous books, the demand for more profound literature will increase.

I feel that every organization composed of scientific men has a due responsibility to the public to-day, a responsibility for two types of worthy books; the popular and the profound, both fulfilling a need and advancing a cause and I can assure you that the publishers of the country, by seeking new markets, by developing new merchandising methods, by cooperating in other ways, will do their utmost to further the growth of this new type of literature.

I predict a future scientific book world far beyond the expectations of even the most optimistic.

After the conclusion of Mr. Crane's address, the chairman called upon Mr. Robert S. Gill, the secretary-treasurer of the Williams and Wilkins Company, Baltimore, who spoke as follows:

The Book Publisher and Science

This is, I take it, an evangelistic meeting. Indeed, I fully expect that a collection in behalf of the benighted will be taken at the close; and I expect, quite as fully, to leave as soon as the offertory sentence is read.

We shall necessarily be evangelistic if we are to discuss ways and means of bringing the fruits of science within the purview of the perpetually peripatetic man on the street. For the world of science undoubtedly has a gospel; and that not an esoteric gospel as for the elect, but a universal gospel as for those who will not even be nominated. Much of the literature of science must be couched in symbols intelligible only to the initiate. But there is another phase of scientific letters—what we may call its catholic epistles—which is addressed to those whose scientific background is general rather than particular.

The gospel of science is utilitarian. It will inform the neophyte as to the laws of hygiene, or the fundamentals of diet. It will enable him so to regulate his living quarters that he may achieve greater comfort with more economy. It can furnish him with devices for his amusement. It can even bring new delicacies to his table.

But the utilitarian aspect of science has been sufficiently stressed. Certainly it has been overstressed if it has been made to appear that utility is the sole purpose of science—as indeed I fear it has. No gospel will find a whole-hearted acceptance which fails to appeal to the whole man—senses, emotions, intellect. The utilitarian may be regarded as the sensual appeal. And there is much more than this to the gospel of science. Its history, the story of its martyrs, of the patient labor, of the aspirations of its high priests, of its triumphs won, of its problems thus far unsolved—assuredly, here is strong emotional appeal. And the insight into the processes of nature, into the sort of world it is in which we live, even into the subtle machinations of the human mind which science makes possible, is distinctly an appeal to that unnamable longing within the breast of every consciously thoughtful individual—the desire to understand merely for the sake of understanding.

The point is one which can not be too strongly emphasized. It appears to me that one of the greatest hindrances to the gospel of science is that we have taught ourselves to think automatically of science as learning, something to be taken when one is in deadly serious, not to say heroic, mood. The gospel won't spread far under such a gruesome handicap. We

must regard science as a literature. We turn to its written works for study, as to works of reference. We look upon them as splendid storehouses of fact, excellent storehouses, to be sure, but still storehouses. What we have missed is that science is good reading, not only valuable but invaluable to general culture. Here is a literature which ranks with philosophy, criticism, *belles lettres,* as cultural warp and woof in the fabric of our many-sided lives. Ranks with them—yes; but measurably greater than any other literature. For cultural values depend upon the stimulation of ideas. It does not seem possible that speculation, comment, narration or plot can possibly be so proliferant of ideas as is the literature of science.

No history has more of human interest than the history of scientific endeavor; even the history of its lost causes and forlorn hopes. It is splendid and human even in defeat. No literature has a greater romantic opportunity. No speculation is so far-reaching, so enticing as the speculation of science; and no speculation has such excellent premises on which to speculate. It is not mere impertinent guesswork. No undiscovered country, no untrodden ground can exceed that of science in extent or lure. Let the wide world of men and women into the secrets of science, let the story be told in pleasing, vivid dress, and the gospel of science will not lack adherents.

The first problem which bobs up is that of translation. Inevitably science turns up so many new concepts that it is obliged to coin new words in formidable numbers. And the recondite vocabulary is by no means all. Science outstrips the language, even assisted by the auxiliaries of Latin and Greek. It uses more signs and symbols than a secret order. Consequently, while the neophyte may, with the aid of a lexicon, a smattering of the classic tongues and a determined spirit, plow through the vocabulary, he is wholly thrown into bewilderment when he reaches the page bespattered with cunning signs and wonders in the way of formulae, which, the author is gratified to state, are inserted in order to illustrate his point.

It is obvious that if science is to reach and inform the average educated mind, something ought to be done about this. Some modern Jerome must set about the writing of a Vulgate. The interpreter must know two languages— the *récherche* glot of the scientific world and the effective, tonal use of something a bit more excellent than high-school speech. It is perhaps not too difficult to phrase scientific concepts in text-book English. But what is wanted is a more creative, a more vivid dress. The combination of researcher and stylist is rare but previous. It is by no means unknown, but we need more of it.

Given a gospel and a body of capable propounders, how shall it be delivered? Traditionally the propagation of a gospel is by word of mouth. Preach it to every creature. But preaching is not a modern method for a modern gospel. We incline to the opinion that oratory is not so much a talent as a vice. Besides which, it appears that times have changed since the days of Confucius or Gautauma Buddha or Jesus of Nazareth. The printing press is a recent invention, which, one may say without too much daring, has had significant effects upon society. Statistics compiled from time to time show that there are a considerable number of people in the United States who can now read without the acquisition of callouses on the end of the forefinger. Reading has become, you might say, almost general.

I believe, too, that among these readers there is a sense of something lacking. There is the Bible, the Sears-Roebuck catalog and the almanac. Yet a feeling has sprung up, of late, that while excellent in themselves, they do not represent truly a well-rounded culture. Even when the *Saturday Evening Post,* the *National Geographic* and the *Literary Digest* are added the final touch somehow seems absent.

So then we have the printed word; and we have certain groups of people skilled in the use of the printed word, who are ready to become disciples as soon as the mourners' bench is declared open. I mean groups who are a bit weary of light reading; who are satiated with modern criticism of men and events; who do not indulge in heavy reading, except to load up with ammunition in order to strike some one dead in debate, and who are seeking *good reading*—something on which to whet the wits, something resilient to chew on, something for mental diversion and mental stimulation at one and the same time.

Enter then the publisher. His rôle is a very humble one. He is merely the messenger, the carrier of the scroll. But for all that not less necessary. He is to the world of science what a transportation system is to the world of commerce, what the camel is to the Sahara desert, what the new Ford is to the erstwhile pedestrian. He is in short guardian of the means whereby the gospel gets from hither to thither.

Let us see what constitutes publication. Publication means the use of movable type to transfer, with reasonably unlimited duplication, the manuscript of the author to white paper and thence to the receptive minds of a considerable number of people. So much is certain. And most people conclude, too hastily, that publication begins and ends with this single function. Which only goes to show how thoughtless people are.

Mere printing of a manuscript is not publication. It is approximately a fourth or a fifth part of publication. It is an initial step and no more than that. Not yet has publication taken place, for nothing has

as yet *been made public.* You must tell people that it has been printed. You must tell them who wrote the book—and why, if possible. You must tell them what is in the book.

And you must say it seductively. It is quite essential that you establish reasons why the book is desirable as a piece of property. For the reader must be made purchaser. Just as the book *printed* is not published so the book *scattered about* is not published. If the thought in the book is to be actually transferred to the minds of readers, then they must be persuaded that it has value. The simplest index of evaluation is the willingness to exchange money for it.

There are many exceptions, of course. Yet it is logical to suppose that by and large the book bought and paid for is the only one truly published. I know of many cases in which quantities of a given book have been distributed without charge of any sort. I know of no such book that has exercised a very profound influence—at least not in this century. We are too suspicious of propaganda.

An experience of my own will illustrate. Last July I bought a copy of Lawrence's "Revolt in the Desert." I seized the earliest leisure moment to fall on it avidly. But I ran afoul of so many weird place names that I foundered at the end of the third chapter. This, I said, is not a book for hot weather. So through August it lay fallow. September came and went. October turned the forest greens to reds and yellows and still I dallied. But November came. I had $3.00 investment at stake. It was as good as wasted unless I read the book. I resolved to get my money's worth. I read the book—and got it. But if I had borrowed that book, I should have returned it unread. If the publisher had sent it gratis, it would still be a mortgage on my future. I can not believe the experience is at all unique.

It is an essential element in publication that people be persuaded to buy. There are several ways of doing this, which I need not describe in great detail: Circulars and pamphlets sent through the mails; the advertising pages of magazines; the distribution of copies for reviews; the making of catalogs; the effective method of mouth to ear which no publisher can either purchase or control. The retail bookseller enters into the picture as a distributing agent, performing an important and exacting service. And the entire process of announcement and of eventual distribution of the book demands careful, long-time planning, an office staff, a store-room, a generous investment—in short, an adequate business organization. I am endeavoring to show how ramified the process of publication is; that an edition is not published on such-and-such a *day,* but that it is a matter of years, since it is not *made public* until the last copy is in the hands of a reader. The commitment to white paper is only a lesser part of the whole; and the accessories are not incidentals, not necessary evils, but belong to the essence of the concept publication.

Superficially, it may seem that this ramified process of making public the gospel of science could be greatly accelerated if the cost were borne in whole or in large measure by the philanthropy of men or organizations able to place subsidies for that purpose in the hands of scientific men. The theory is so persistent and so fallacious that it seems worth while to analyze it. Subsidy goes quite far enough when it makes the research possible which turns up the necessary material. Every dollar spent in publication is a dollar taken from discovery. It would seem that the public can not, with good face and grace, ask to be relieved of the lesser burden—if burden it be.

But that is not the best reason why subsidized publication of scientific work should be summarily dealt with. It is a positive menace to the spread of the gospel of science. It is a standing notice to the world at large that the literature of science has no or little value. It reduces the literature of science to the level of propaganda, a degrading level, indeed. And, finally, while subsidy may succeed in placing a large amount of material in the *hands* of people it by no means guarantees that the material will find a resting place in the *minds* of readers. My opinion is that, by and large, it sets up a real barrier to mental receptivity. And the book gathering dust as an ornament on the library shelf is no more published than the same manuscript in the hands of the author. Subsidy is a danger because it does not win support; its very nature dictates that it shall say, in effect, that support on the part of the public is not wanted. It is an invitation to stay outside.

Not only the literature of science but science itself can not prosper without public support. The distribution of the literature, the spread of the gospel is a commercial problem rather than a problem in mendicancy. If a book can not be published without subsidy that is one excellent reason why it should not be published. There may be still more excellent reasons why it should; but at least the necessity of subsidy is one which ought to give pause.

Quite obviously, if the gospel is really to be spread, it must have a multitude of patrons, not a multitude of the patronized. And the reader who is also purchaser should realize that not only is his purchase something of value to him, but that he is a patron of the sciences, in no loose metaphorical sense, but quite literally and exactly. It is a fine thing to say. The gospel of science must be spread, regardless of profits.

But the sober truth is that the gospel of science *can not be* spread regardless of profits—that is to say, regardless of the ordinary laws of the exchange of goods of value.

It is really unfortunate that in the process of reading a book, it is not *read up*. It may be loaned as many times as you please; and no doubt a part of the pleasure of owning a book is the privilege of lending it. But observe the other side of the matter. For comparative purposes, contemplate a can of tomatoes. After it has been used by one user, no one else will even look at it. Even the original user comes back in due course for another copy of the edition. But it isn't so in books. Keep in mind that every time you lend a scientific book, you are putting sand in the wheels of scientific progress and denying some one the privilege of being a patron. I can scarcely expect that the nefarious practice will cease. But at least my conscience is now clear. If you persist, the culpability is none of mine and you will know the full depths of your iniquity.

Certainly books are not too expensive to buy. Pay $5.00 for a couple of theater tickets. Three hours' diversion, a handful of ideas, a stimulation of the appreciation of thespian art and a fading memory of a pleasant and profitable evening is your return. Pay the same or less for a book. You get in return eighteen or twenty hours' diversion, probably a larger handful of ideas, certainly an equal stimulation; Mary reads it too; Willy comes along and reads it; maybe Jean will take a dip into it. And you have a permanent addition to your library, an adornment for the living-room table and a permanent advertisement to visitors that you are a man of mental substance. I don't urge you to eschew the theater—I merely point out that the price comparison is favorable to the book.

Or again. A hundred dollars a year spent on books is a rather munificent sum. I am quite sure, if we had a laboratory record, that this audience would not average that sum for the year closed yesterday at twelve noon. Yet the same sum is hardly sufficient to keep an average family in good physical trim, with the fixings we all add, for a month. Again, I don't advocate giving up the table or the joys of it. I allude merely to the fact that mental pabulum is much cheaper than that furnished by the butcher and grocer.

Cheap as books are, however, they may be made cheaper. Every purchaser is a supporter. If the support gains in volume, the contribution each must make is necessarily less. And the increase in support will not result in a lowering of the quality of the product. It may result in more books, but it will surely result in better books, too. For more books will be written. There will be a wider field from which to select for publication. And that wider support will come when books are written which the public likes. No publisher can be found, I am sure, who can give a recipe for a best seller. It is no magic of skilful advertising, despite general opinion to the contrary.

I have endeavored to develop the thought that the problem of the publication of scientific books, of the spread of the gospel of science, has two facets.

First, the problem of translation. Here the onus lies upon men of science. There is no saying that this subject or that discipline is too technical, too recondite to be given the touch of human interest. Once upon a time I studied comparative religion. A duller, stupider subject I can not easily imagine. But see what Lewis Browne did with it in "This Believing World." Philosophy was drier than a political speech in Kansas until Will Durant showed its far-flung appeal. Here is a duty which science owes to the world—and to itself. Duty, did I say? It ought to be a pleasure.

Secondly, the problem of distribution. And this is essentially a problem of the book trade; publisher and retailer must, it would seem to me, join forces here. No doubt much thought, much experimentation and much planning have already gone into the problem of better serving the book-buyer. Yet I feel sure that the book trade is far from satisfied with its efforts. Some idea of the magnitude and intricacy of the task of ready book distribution may be gained when I tell you that I myself, personally, have devoted thought, energy and experiment to it for four years without reaching a satisfactory conclusion.

Probably it isn't the problem of any one publisher, and no publisher can by himself solve it. Probably the solution will be approached only when desire to solve it becomes keen enough to overcome the inertia which must be overcome before men work and plan and build together. The natural tendency is to go it alone.

One thing, however, seems clear—so clear that it is almost trite even to mention it. The beginning of the solution lies in the study, not of new advertising stunts, not of go-getting sales methods, not of the internal affairs of publisher or retailer; but in a patient and painstaking study of the needs and requirements of the buyer and prospective buyer of scientific books, whether we think of the specialist or of him whose scientific reading will be for general cultural values.

I may even go so far as to set forth what those needs and requirements seem to me to be, subject, very decidedly, to addition and emendation.

First, the scientific reader wishes to know what books there are in the field in which he is interested; what new books are being published; what are the books published in that field in, let us say, the last five years; a sort of rough-and-ready bibliographic service. Such a service might be rough and ready, but it need not be haphazard. It can tell him what he wants to know, not a tenth part of what he wants to know. It can be made to do this without requiring long laborious search on his part.

Secondly, the books that fall within his purview must be made accessible to him. They must be placed where he can see, touch and handle them.

Thirdly, I believe he would welcome some method whereby he might spread his book expenditures evenly throughout the year. By no possible fortuitous concatenation of circumstances can it occur that the twelve (let us assume) books he will buy in 1928 will be published conveniently each in a calendar month. Any arrangement which would make it possible for the buyer to procure what he wants when he wants it and make payment for his purchases in regular periodic sums is one which I am reasonably sure would foster the spread of the gospel of science.

I wish it were as easy to meet these natural requirements in practice as it is to recite them in theory. They present more ifs, ands and buts, more whereases and aforesaids than an obituary resolution on a deceased member of the lodge. I shan't bore you with the details. I have already tried your patience sorely enough.

I would add one concluding thought. Men and women of science such as are gathered together at this conventicle can perhaps do more than any other group of like number to spread the gospel of science not only among avowed students but in casual contacts of every sort, to encourage the reading of scientific material, to saturate the public mind with the scientific point of view. I need not point out in detail how hopelessly befuddled the public mind is in its thinking about science. I need scarcely say that a reasonable grasp of scientific viewpoint would tend toward the public weal. Far be it from me to suggest any addition to the responsibilities under which men already groan. But a discussion of this nature can scarcely fail to direct attention to this task of scientific men. I close, therefore, as is proper in evangelism, with a pious exhortation: Go to it and God bless you!"

Following Mr. Gill's address, Mr. Watson Davis, of Science Service, sketched the history of that organization, and explained its function and its aims.

In introducing the speakers at the afternoon session, the chairman said:

Thirty years ago very many, though by no means all, of our research workers were to a large extent isolated from their fellow men. They were usually connected with a university or some other institution, and had few contacts with the world beyond. Wholly absorbed in study and possessed of a laudable determination to add as much as possible to the knowledge in their own special field, they were self-centered and often unapproachable. Their work was everything to them, a sacred thing not to be profaned by exposure to the public gaze. Their attitude toward the public was one of supercilious indifference. They seemed to say to every one, "I am it."

Thirty years ago science did not by any means play the part in our daily lives that it does to-day. Many of the fundamental facts of science, now become a basic feature of the automobile, the radio and many other every-day necessities, were at that time known merely as laboratory curiosities. The popular science of those days as we saw it expounded in the daily press read like a strange and weird mythology.

At that time so many of the research workers felt themselves quite detached from and superior to their fellow men, the average representative of the press was perhaps not quite so highly educated as he might have been, at least in scientific lines. Yet at the same time he was human. Scenting a story in a laboratory, he frequently met with a rebuff, or at least felt himself to be in an uncongenial atmosphere.

The "I am it" attitude radiating from the scientific worker enveloped the news seeker. Nature at once was ready with an antidote and the news seeker promptly assumed an attitude of complete indifference.

Times now have changed. The average research worker of the present day is by no means so detached from contact with his fellow men as he used to be. He is far more given to cooperating with his fellows. He is commonly supported wholly or in part by public funds, or is connected with institutions which are much less isolated from the world about them than they were thirty years ago.

What is the reason for this change? The reason is that science has come to play a greater and greater part in the lives of every one. The scientific luxuries and curiosities of thirty years ago are now necessities. This has given rise to an increased interest in all things scientific.

With the increase in the popular interest in the facts of science has come a wholly different attitude on the part of those who seek out scientific news. Now they are for the most part reliable and accurate, striving to present science in a wholly truthful light for the good of all.

The two contrasting attitudes of thirty years ago, the research worker's "I am it" and the reporter's attitude of complete indifference have now been largely merged into a common attitude on the part of both, "let's get together."

However, tradition still is strong, and the cooperation is not yet so complete as perhaps it might be. So we are gathered here to-day to survey the problem of bringing science to the people, to make a frank confession of the difficulties of both sides, and thus to arrive at a better understanding.

The chairman next called upon Mr. David Dietz, science editor of the Scripps-Howard newspapers.

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(*To be continued*)

RESEARCH NOTES FROM THE HARVARD OBSERVATORY

THE investigations described in the following paragraphs appear to have a wider interest than many of the routine astronomical researches at the observatory, and they are here abstracted with a minimum of technical detail.

New Variable Stars: One of the foremost problems of the Harvard observatory has always been the discovery and study of variable stars. In addition to the general search for variables on the regular plates, the past two years have seen the beginning of a special intensive study of the faint variables in the Milky Way from plates taken in series for the purpose.

Between four and five thousand variable stars have been discovered at Harvard since 1890, and the rate of discovery is not decreasing, for in the interval from September 30, 1927, to May 1, 1928, the discovery of five hundred new variable stars has been announced, and two hundred more await publication. Miss Swope has found about half of these seven hundred stars in one special Milky Way region; Miss Woods, in another Milky Way region, has discovered over a hundred and fifty; sixty have been noted by Dr. Luyten in the blink microscope while looking for proper motions, and Professor Gerasimovič has found thirty in a special search of the Harvard map plates. In addition, two novae have been discovered by Miss Woods.

The mere discovery of variables is not of great significance; but when certain regions have been thoroughly examined, and the types and periods of the variables determined, we have important information about the district of space in which they are situated. Dr. Luyten, Professor Gerasimovič and Miss Swope have been able to determine the periods of many of the stars on their lists, and for many others the type of variation can confidently be assigned. If the other regions of the Milky Way are as rich in variables as the one hundred square degrees in which Miss Swope has discovered over three hundred fainter than the tenth magnitude, the number of undiscovered variables must be enormous. It seems likely that this particular region is a very rich one, and the results of close examination of neighboring parts of the sky are awaited with great interest.

The Fall of Meteors into Stars: Interstellar space evidently is numerously populated, for it has been reliably estimated that the earth's daily catch of meteoric bodies is about thirty million. Perhaps as much as thirty tons of matter, largely iron, is caught by the atmosphere every twenty-four hours. The smaller bodies are destroyed by the heat generated as they penetrate the atmosphere; the larger ones are the fireballs from whose high velocities we infer that some, at least, are of interstellar origin. Because the sun is larger and more massive than the earth, the number of meteors that it catches must be far greater; in fact, the sun must accumulate in this way much matter that is a potential source of radiated energy. Two thousand tons per second is a fair estimate of the intake; four million tons per second is the computed outgo in the form of radiation.

There are undoubtedly more densely populated regions of space than the one through which the solar system is now passing; the Pleiades, for instance, are enmeshed in nebulosity, which shines mainly by reflected light, and therefore consists of solid particles. The amount of matter captured by Alcyone, the brightest of the Pleiades, must greatly exceed that caught by the sun, because the neighborhood is richer in supplies, and because the star is many times larger, and probably ten times as massive as the sun. The collecting power of large and massive stars in heavily nebulous regions may well bring them millions of tons of matter a day.

Every meteor is a typical comet and may be expected to yield a cometary spectrum under appropriate conditions. Such conditions arise when the comet or meteor is near a star; for the solar comets we observe an emission spectrum to which cyanogen, nitrogen and hydrocarbons contribute the more typical features, and in which iron has also been recorded. The same molecules are also competent to produce an absorption spectrum, and we should expect to find the corresponding absorption lines in the spectra of meteor-infested stars—especially of massive stars, and of stars in nebulous regions. And in fact we do find absorption lines when we have realized how their

appearance would be modified by the nature and situation of their source.

Four years ago a diffuse absorption band was recognized in the region of the third cyanogen band (4215 A), and more recently I have called attention to its widespread occurrence in the early type spectral classes, and its frequent association with a diffuse absorption in the region of the fourth cyanogen band at 3883 A. The diffuseness and absence of a definite band head are believed to be the result of the Doppler shift, caused by the rapid orbital motions of comets and meteors near the stars and by the high velocities as they plunge into the hot stellar atmospheres. Their velocities are at a maximum when their absorbing power is probably greatest—in the few minutes during which they are quite close to the surface of the star—but they are doubtless effective absorbers for a long time before, perhaps for the week during which they are approaching the star.

Besides occurring in the spectra of many early type stars, the cyanogen bands also appear in those of later stars, where, however, they are obscured by normal stellar cyanogen. The cyanogen absorption, moreover, is accompanied in many stars by a wide absorption band that corresponds in wave length to the ultimate lines of iron, and the strongest lines of magnesium within the photographic range. The two commonest metallic constituents of meteors are iron and magnesium, and they are evidently represented by their most easily excited lines in the spectra of the stars that are in the act of absorbing meteoric material.

The solar system at present does not receive a representative share of meteoric visitors, and its cometary system has probably been depleted by age and planetary perturbations. An indication of the significant rôle that meteoric matter may play in the universe only begins to appear when we correlate terrestrial fireball phenomena, spectrophotometry by the newer methods, and the study of nebulae.

Bright Lines in Stellar Spectra: Theory has recognized two ways in which bright lines may arise in the spectrum of a star; they may be the effect of a nebulous envelope, or they may originate from a special accumulation of atoms above the photosphere. The bright lines produced by a nebulous envelope are essentially fluorescent, and the spectra of nebulae, nebulous stars and Wolf-Rayet stars may be interpreted in this way. An example of the other class of bright lines is furnished by the reversal of the H and K lines in the solar spectrum, an effect typical of many late dwarfs, and produced by the floccular regions at the surface. These two mechanisms for the production of emission lines are effective for stars of constant brightness in a steady state; the problem of the emission spectra of variable stars is as yet theoretically untouched.

Professor Gerasimovič has recently considered the enigmatic problem of the emission spectra given by supergiants of classes B0 to F5; they show the bright lines of hydrogen and ionized iron—lines that require considerably less energy of excitation than the absorption lines of helium and doubly ionized silicon that accompany them. The immediate inference is that the bright lines originate at higher pressures than the absorption lines, and therefore deeper in the atmosphere, and this supposition is borne out by the observed structure of many such emission lines, which show a fine central reversal.

The appearance of emission lines, as Professor Gerasimovič has shown, also requires that the electron temperature be higher than that of the stimulating radiation from the photosphere, and this condition is not fulfilled in the atmosphere of the normal star. He finds a possible cause of relatively high electron temperature in local sources of hard radiation of very short wave-length, situated not far below the surfaces of stars that have emission spectra. At the centers of stars the radiation is all of exceedingly short wave-length, but for most stars it is transformed by Compton scattering, and emerges from the surface with a normal Planckian distribution corresponding to a temperature of a few thousand degrees. For a hard enough source, situated near enough to the surface of a star, Compton's mechanism can not complete the transformation to black body radiation; it is possible that free electrons with high velocities may even increase the frequency of the radiation which traverses the strata they occupy. The hard radiation that emerges from the surface raises the electron temperature and fulfils the condition for the production of bright lines.

The atmospheres of the early supergiants thus seem to be superexcited, and we may expect this condition to be accompanied by abnormal luminosities and temperatures. Professor Gerasimovič himself has lately shown statistically that the luminosities are in fact abnormal; the temperatures, as inferred from colors, are less suited to statistical treatment, but he confirms the low temperatures derived by other workers for early supergiants by finding for P Cygni (Class B1p) the striking temperature of seven thousand five hundred degrees, less than half the temperature usually assigned to Class B1.

The Meteoric Procession of February 9, 1913: On the night of February 9, 1913, a most remarkable procession of large and brilliant fireballs crossed the sky. They traveled about forty-three hundred miles in eight minutes, for they were seen from Saskatchewan to Long Island, and observed from ships at sea south

of the equator. The motion of a satellite-like meteor, passing through the upper atmosphere, presents a serious dynamical problem, and the observations of the procession were so difficult to reconcile with the kind of path that the fireballs were supposed to have taken that several investigators actually questioned the reliability of the data. The fireballs were seen by many people in Ontario, and the height at which they passed was definitely found to be 26.4 miles. It was questioned at the time whether a swarm of meteors passing Canada at so low an altitude could persist in its motion near the curved surface of the earth for three thousand miles; moreover, some of the observations made from ships fell by several miles on the wrong side of the projected great circle path that best represented all the northern observations.

Dr. Fisher has recently examined the data again, and he concludes that the observations can now be satisfactorily interpreted. The swarm of fireballs, he considers, was an extensive one, so that the lower members seen in Saskatchewan and Ontario fell into the Atlantic near the coast, and their companions, which passed unobserved over Canada at greater altitudes, were the bright fireballs observed from ships in the southern Atlantic. Dr. Fisher has succeeded in interpreting the observations by considering two factors previously neglected; the earth's equatorial bulge and its daily rotation. It is the existence of the equatorial bulge that draws a satellite meteor towards the earth's surface as it rushes through the atmosphere. The effect of the earth's rotation is perhaps more striking; a meteor entering the atmosphere moves relative to the earth as a whole, not to the rotating surface, and therefore the projection of its path is not a great circle—it turns out in this case to be a curve, concave (in the northern hemisphere) to the southwest, and having a turning point at the equator. All the reliable observations of the swarm of February 9 are satisfactorily represented by such a curve, and their satisfactory interpretation marks an advance in the study of the dynamical problem of the motions of meteors.

In his researches on meteors, Dr. Fisher is effectively studying the fundamental cosmic problem of the composition and motions of the population of interstellar space, and a knowledge of the dynamics of meteors is one of his more important tools. If other fireballs, or swarms of fireballs (the so-called minor comets) could be observed as widely as the swarm of 1913, and with greater accuracy, the study of interstellar space could become an individual science. But like all other sciences, it requires a basis of accurate and systematic observation, and at present the student of interstellar visitors is dependent for his facts upon an unprepared and uninstructed public. To educate them is perhaps his foremost task.

HARLOW SHAPLEY

FAMILY NAMES

THE International Code of Zoological Nomenclature dismisses the subject of family and subfamily names with two very brief pronouncements:

> Art. 4. The name of a family is formed by adding the ending *idae*, the name of a subfamily by adding *inae*, to the root of the name of its type genus, and
>
> Art. 5. The name of a family or subfamily is to be changed when the name of its type genus is changed.

A very serious difficulty arises from two points of view, each extensively employed by taxonomists, as to what shall constitute the type genus of a family.

The one point of view is that the oldest contained genus, *ipso facto*, regardless of other considerations is the type genus of the family. The other school considers that the first author to employ a contained generic name with a plural ending, with the significance of a group higher than genus (whether he called it family, subfamily, tribe, cohort, legion, phalanx or what-not) by that fact established the genus in question as type of the higher group and that his action is not subject to change.

The principle of establishing a type, whether of a specimen for a species, a species for a genus or a genus for a higher group, is the same. It is founded upon recognition of the fact that authorities disagree and have an inalienable right to disagree as to the limits of groups—whether species, genus or family. Therefore, when an author proposes a new species or a new genus or a new family, he is not at liberty to bind the future as to the limits which the group shall assume—no code recognizes his right to do that, for that is a matter of taxonomic fact and of personal judgment, not subject to fiat. All he can do (so far as the codes of nomenclature are concerned) is to establish a nucleus for his group—the type specimen or type species or type genus, as the case may be, and all that a code of nomenclature can do is to establish, in case the original author did not make it clear, *what* that nucleus is, and having once established that, then they proclaim that in the future said nucleus or type together with all other individuals that are considered cospecific with it or species congeneric with it or genera belonging to the same family, as the case may be, shall always and forever be called by the group name which the original author proposed, provided he met certain requirements as to form of name and was not anticipated in his action by others.

This principle is very fully recognized for genera and their type species. The code enters at length into the really very intricate matter of determining just what species shall be accepted as type in the case of the legions of genera that have been proposed only from the point of view of their *limits* (that is, by diagnosis) and not from point of view of their *nucleus,* that is, by type designation. It is one of the most important matters of nomenclature and involves a great deal. Owing probably to the greater difficulty of dealing with concrete objects, the International Code does not refer to the type specimens of species. But the principle is well understood and in general use in that connection.

There seems to be neither logical reason nor practical reason why the same principle should not be applied to groups higher than genera. And in their cases the matter is more simple, for there is never any question as to the intent of the original proposer of a subfamily or family as to its type. His intent is definitely established by the stem of the genus that he employs to which is added a patronymic or plural ending.

The only question is, shall we rule that the original proposer of a group higher than genus was not at liberty to choose a type genus to represent it, but must perforce use the oldest contained genus as type, and if he failed to do so that his work was invalidated?

The very great danger of such a procedure is that it is a departure from the principle of *nucleus* toward the principle of *limits* and thus a serious trespass in a nomenclatorial question upon the precincts of taxonomy. For it is obvious that, under that ruling, if Smith includes in his new family only A-us 1850 he must call the family A-idae. But if Brown includes both A-us 1850 and B-us 1825 in the family he must call it B-idae, for to him the type genus must be the older B-us, and if Black, with still different taxonomic views, includes also C-us 1800, to him the type genus would be C-us and the family name C-idae. And yet all might be contemporaneous workers and with perfectly reasonable but altogether different convictions as to the proper limits of that family.

Is it not, therefore, obvious that insistence upon the principle that the oldest contained genus is *ipso facto* type destroys the whole idea of a type or nucleus, for it utterly disregards the intent of the proposer of the group, as expressed in the name he used, and sets up as a standard for the family name a base that may fluctuate with every realignment of the family limits. If that practice had been contemplated by the framers of the code, they would have worded Article 4 to read, "The name of a family is formed by adding *idae,* the name of a subfamily by adding *inae,* to the root of the name of its oldest contained (instead of type) genus." The very fact that they used the word type genus and went into no further detail or explanation leaves the warrantable assumption that type genus implies a meaning and application of the term type similar to that which is well understood and fully discussed in the code in connection with the type species of a genus.

When an author recognizes for the first time the taxonomic affinities existing between certain genera and proposes to group them together as a group of greater rank than genus, he in so doing performs an act of at least equally great taxonomic significance with that performed by the describer of a new genus. He has founded a potential family, regardless of the rank that he assigns his group, just as the proposer of a "variety" founds always a potential species. If in proposing the group he establishes for it a name, he is performing not only a taxonomic act, but also a nomenclatorial act, of at least equal importance to the coining of a new generic name. If the proposer of a generic name does not meet certain arbitrary conditions that we have laid down, as, for example, if his name is not uninomial, the name is outlawed. Likewise, if the proposer of the new group name does not meet certain conditions, specifically if he coins a name instead of using the stem of a generic name from within his new group plus a plural termination, his name is outlawed. But if he *has* met those conditions, then from the standpoint of nomenclature and of taxonomy he has founded both a potential family and a family name (save only possible modification of termination to suit the rank), and it makes no possible difference (nomenclatorially) what rank he assigned it, for that is again a question of taxonomic perception and not of nomenclature.

I wish to propose for the consideration of the zoological profession and for eventual transmission to the International Commission on Zoological Nomenclature for consideration as an amendment to the code, the following paragraphs:

(a) The type genus of a family or subfamily shall be the contained genus of which the stem of the name was first employed in combination with a termination in Latin plural form to designate a group higher than genus. If any termination was originally used other than provided for in Article 4 of the code, said termination shall be changed to bring it into conformation with that article.

(Older authors rarely used the terminology to-day required.)

(b) The name of a family or subfamily shall date from the time it was first proposed as a group higher than genus, provided it was based on a contained generic name.

(The older authors used many terms to indicate groups equivalent from a nomenclatorial standpoint to what we now call family and subfamily.)

(c) *Recommendation.* When erecting a subfamily or family, an author should choose the oldest valid contained genus as type, whenever feasible; but no family or subfamily name is to be changed because its type is not the oldest contained genus.

Upon the Changing of Family Names

If a family consists of its type genus and all other genera that any given taxonomist considers should be associated with it, then that type genus may never be changed without nullification of the principle of type and of priority; and since the *name* of the type genus can not be changed, unless it is a homonym, the *name* of the family can not be changed, except in the same case.

If common usage is based on the misapplication of the name of the type genus of a family, then common usage will also be misapplying the family name to a group of genera that actually should not come under it. The restoration of the name of the type genus to its correct sense under the code will involve the application of the family name to an unfamiliar group of genera to which current usage has not applied it, and will leave the group of genera to which it has been incorrectly applied (since its type genus is not one of them under the code) under the necessity of being fitted with a different name and type genus. That is in no sense a change in the family name nor that of its type genus. It is a corrected application of each.

To make this quite clear, let us assume that A-us type of A-idae is currently used as though Y (not an originally included species) were its genotype, and consequently the family A-idae as though it consisted of A-us (A-us y) + B-us + C-us (B-us and C-us being two genera of the same family group as A-us y). But under the code the only originally included species A-us z must be type of A-us, and A-us z is not of the same family group as A-us y, or B-us or C-us. Therefore, under the code A-idae really consists of its type genus A-us (but with species z, not y) + such other genera as belong to the same family group as A-us z, let us say E-us and F-us. This leaves the genus containing A-us y without a name, and the family group A-us y + B-us + C-us without either a name or a type genus.

It follows that the only case in which the name of the type genus of a family can be changed is in case it is a homonym. I, therefore, wish to propose the following modification of Article 5 of the code, in the interests of precision and clarity:

Art. 5. When the name of the type genus of a family or subfamily is found to be a homonym, it must be changed to correspond to the change of the name of its type genus.

J. Chester Bradley

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SCIENTIFIC EVENTS

THE BRITISH EXPEDITION IN EAST AFRICA

The trustees of the British Museum announce, according to the London *Times,* that a valuable work in scientific research, which already has added considerably to knowledge of fossil remains, is likely to be checked owing to lack of funds to carry it through.

In 1924 the trustees sent an expedition to the Tendagura district of Tanganyika Territory, which is particularly rich in fossil reptiles, and especially in forms whose nearest representatives are to be found, it is believed, only in North America. Before the war several German expeditions collected in the district much material relating to the dinosaurs, but they left many gaps, and it was to fill those gaps that the British expedition went out under the leadership of W. E. Cutler. Mr. Cutler's assistant was L. S. B. Leakey, an undergraduate who could speak Swahili fluently, but Mr. Leakey had to return after a few months in order to resume his studies at Cambridge. Mr. Cutler carried on without an assistant, but died of malaria at Lindi in August, 1925. F. W. H. Migeod then went out, accompanied by Major T. Deacon, and they returned to England in 1926. Early in 1927 Dr. John Parkinson was appointed leader and Major Deacon went back with him.

As a result of the expedition over 500 cases of specimens have been received at the museum, and much work has been done in mapping out the geology of the Tendagura district. Dr. Parkinson has also visited the site at Koru, in Kenya, where interesting fossils have been found. It is desired that the line extending westwards of Tendagura towards Lake Nyasa should be explored to ascertain whether dinosaurian and other fossil remains occur along the course of the ancient river.

The cost of the expedition has been met partly from the reserve fund which had been accumulated by the trustees and partly from a special fund to which well-wishers subscribed in 1924. The former fund is low and the latter will soon be exhausted; without further help the expedition must be brought to an end next December. About £3,000 is the annual cost of the expedition. This is considerably more than the trustees

of the British Museum can provide for the purpose out of the Parliamentary grant, but they hope that many of those interested in East Africa and in geological research may lend their aid by contributing to the special fund.

AN INTERNATIONAL BASIS FOR ELECTRICAL UNITS

By amendment to the International Convention on Weights and Measures it has been provided that electrical units and standards shall be dealt with through the organizations which have jurisdiction over the fundamental units of measurement. These organizations are the international general conference, the international committee and the International Bureau of Weights and Measures.

The seventh General Conference on Weights and Measures, held in 1927, approved the formation of a committee on electricity to advise the permanent International Committee on Weights and Measures on questions relating to electrical standards and systems of measurement. This advisory committee was limited to ten members, including a representative appointed by each of the national laboratories designated by the international committee and additional specialists named individually by that committee. It was provided that a member of the international committee should be chairman of the advisory committee and that a report should be rendered by it not later than March 1, 1929.

The national laboratories designated are the National Physical Laboratory of Great Britain, the Laboratoire Central d'Electricité at Paris, the Physikalisch-Technische Reichsanstalt of Germany, the Central Chamber of Weights and Measures of the Union of Socialist Soviet Republics (Russia), the Electrotechnical Laboratory of the Department of Communications of Japan and the National Bureau of Standards of the United States. Of the four additional members only two appointments have been announced. These are M. Chas.-Éd. Guillaume, director of the International Bureau of Weights and Measures, and Professor L. Lombardi, of Rome, Italy.

An American advisory committee has been formed to assist the Bureau of Standards in formulating proposals representing a consensus of the opinions held in this country. The organizations invited to take part and the representatives named as members of this committee are as follows:

National Academy of Sciences—Professor A. E. Kennelly.

American Institute of Electrical Engineers—Professor A. E. Kennelly.

American Physical Society—Professor Henry Crew.

National Electric Light Association—Dr. Clayton H. Sharp (alternate, A. B. Morgan).

Association of Edison Illuminating Companies—Dr. Clayton H. Sharp.

National Electrical Manufacturers Association—W. J. Canada.

American Telephone and Telegraph Co.—A. B. Clark.

The American advisory committee met at the Bureau of Standards on June 16, 1928, together with a number of members of the staff of the bureau. After due consideration of the information available regarding the present status of electrical measurements, the committee unanimously adopted the following resolutions:

1. *Resolved,* That, in the opinion of this committee, in view of improvements which are being made in absolute measurements, electrical standards should in future be based upon the absolute system of units.

2. *Resolved,* That, in the opinion of this committee, the functions which it is desirable to have the International Bureau of Weights and Measures undertake in connection with the electrical units are as follows: (1) A central secretariat to arrange for systematic exchange of standards and compilation of results of intercomparisons thus made among the national laboratories. (2) A laboratory to which concrete standards representing the results obtained in the different countries may be brought for precise comparisons. (3) A repository for international reference and working standards with the necessary equipment so that other standards may be compared with these standards on request.

Resolutions of similar purport have been under consideration by committees of the American Institute of Electrical Engineers for some months, and were finally approved by the board of directors during the Denver meeting, June 25 to 29, 1928.

MEETING OF THE AMERICAN PUBLIC HEALTH ASSOCIATION

The American Public Health Association will hold its fifty-seventh annual meeting at Chicago, Ill., from October 15 to 19, with headquarters at Hotel Stevens. Two other national health organizations, the American Child Health Association and the American Social Hygiene Association, will meet jointly with the American Public Health Association. The first general session will be called Monday evening, when Dr. Herman N. Bundesen, president of the American Public Health Association, will give the presidential address, and either the president of the American Child Health Association or his representative will also speak at this opening meeting. The second general session, scheduled for Wednesday evening, will be devoted to a discussion of the following topics: Our organizations for the care of the sick; which public

health procedures pay, and how to use effectively civic groups in promoting health programs.

Sanitarians and persons interested in preventive medicine will this year have unusual opportunities to hear reports and discussions of the latest findings in their particular field, for the sessions of the week have been increased over the number of previous years.

There will be a total of 42 sessions; 31 of these will be meetings of sections of the association including health officers, industrial hygiene, food, drugs and nutrition, laboratory, public health engineering, child hygiene, vital statistics, public health education and public health nursing.

Special sessions have been arranged for the discussion of cancer, training for the public health professions, dairy products and epidemiology. The joint sessions will bring together these sections: health officers, public health nursing, child hygiene; laboratory and food, drugs and nutrition; laboratory and public health engineering; child hygiene, public health education and the health education division of the American Child Health Association. The health officers will devote one session to rural health work.

A symposium on pre-school health supervision procedures will be treated from the angle of the small town and rural areas, the small city and a limited area of a large city. Infant mortality studies, and maternal mortality, school medical and nursing service, medical service in continuation schools, sickness and absence records in the school health program and objectives of dental health education will be discussed in the child hygiene section meetings with the American Child Health Association.

The public health engineering section has planned symposia on sterilization of milk utensils, shellfish sanitation, methods of financing water supply and sewerage improvements. Atmospheric pollution by smoke and odors, useless noises and their relation to public health, and schoolroom ventilation as it is related to absenteeism will be discussed by this group. A practical problem to be presented at a session of the engineers will be carbon monoxide pollution of air in Chicago.

THE FOURTH INTERNATIONAL CONGRESS OF ENTOMOLOGY

As this is written, July 23, the plans for the congress are in practically their final form, while the program is nearly complete and will go to the printer in a few days.

The following countries are sending delegates: Argentina, Australia, Austria, Belgium, Bulgaria, Canada, Chile, China, Cuba, Czechoslovakia, Denmark, Egypt, Great Britain, Finland, France, Germany, Hawaii, Hungary, Italy, Ireland, Japan, Mexico, Netherlands, New Zealand, Poland, Porto Rico, Roumania, Scotland, South Africa, Spain, Sweden, United Soviet States of Russia, Norway, Guatemala, Greece, United States.

The congress opens on Monday morning, August 13, at 9 A. M. with a brief address of welcome by Dean A. R. Mann, followed by the opening address of the president, Dr. L. O. Howard, after which the congress will proceed at once with the reading of the following papers during the general Monday morning session:

"Le peuplement de l'Amérique du nord par les Trechinae." Dr. RENE JEANNEL, Vivarium, Museum national d'Histoire naturelle, Paris, France.

"Problems of Distribution and Variation of North American Fleas." Dr. KARL JORDAN, Zoological Museum, Tring (Herts), England.

"Development of Entomological Science in Egypt." Dr. HASSAN C. EFFLATOUN BEY, Plant Protection Section, Giza, Egypt.

Report by Dr. KARL JORDAN, secretary of the executive committee.

SECOND GENERAL SESSION

Tuesday, 9 A. M., August 14, 1928.

"Klima und Seuchen von Standpunkt des Entomologen." Dr. E. MARTINI, Institut für Schiffs- und Tropenkrankheiten, Hamburg, Germany.

"On the Splitting Influence of the Increase of Entomologists' Knowledge and on the Enigma of Species." Dr. WALTHER HORN, Deutsches Entomologisches Institut, Berlin-Dahlem, Deutschland.

"The Relation of Taxonomy to Other Branches." Professor F. SILVESTRI, R. Instituto superiore agrario, Portici, Napoli, Italia.

"A Neotropical Myremecophyte (Cordia alliodora) and its Tenants." Professor WM. M. WHEELER, Bussey Institution, Harvard University, Forest Hills, Massachusetts.

THIRD GENERAL SESSION

Thursday, 9 A. M., August 16, 1928.

"The Mutual Relationship between Museums and Experts." Dr. W. J. HOLLAND, Carnegie Museum, Pittsburgh, Pennsylvania.

"Freshwater Living Hymenopterous Parasites in Russia." Professor M. N. RIMSKY-KORSAKOV, University, Leningrad, Russia.

"Fauna of the Soil in Swedish Forests." I. TRÄGÅRDH, Experimentalfältet, Sweden.

"Insect Inhabitants of the Upper Air." Dr. E. P. FELT, Entomologist, Bartlett Research Laboratories, Stamford, Conn.

"Restrictions Enforced by the United States on Entry of Foreign Plants and Plant Products for the Pur-

pose of Excluding New and Dangerous Pests." C. L. MARLATT, chief of the Bureau of Entomology, Washington, D. C.

FOURTH GENERAL SESSION

Friday, 2 P. M., August 17, 1928.

"Evolution of Cycles and the Origin of Heteroecy in Aphids." Professor A. K. MORDVILKO, Academy of Sciences, Leningrad, U. S. S. R.

"Das Mimicryproblem und Seine Schwesterproblems." Dr. FRANZ HEIKERTINGER, Wien, Oesterreich.

"Insect Control of Noxious Weeds." Dr. A. D. IMMS, Rothamsted Experimental Station, Harpenden, England.

"Biological Control of Noxious Weeds." Dr. R. I. FILLYARD, chief entomologist, Canberra, F. C. T., Australia.

Report of the executive committee.

Election of members for the permanent committee.

Selection of a place and date of meeting for the Fifth International Congress. Election of the president. Closing remarks by Dr. L. O. HOWARD.

The general morning sessions will be followed by the afternoon sessions, where upwards of one hundred papers will be read on the various phases of entomology, by leading authorities of foreign countries, Canada and the United States. The congress will spend Wednesday, August 13, at the State Experiment Station, Geneva, New York, where the program will be continued.

G. W. H.

SCIENTIFIC NOTES AND NEWS

DR. T. WAYLAND VAUGHAN, professor of oceanography in the University of California and director of the Scripps Institution of Oceanography, has been elected a foreign member of the Linnean Society of London. Other Americans holding this honor are Professor E. B. Wilson, of Columbia University; Professor G. H. Parker, of Harvard University; President H. F. Osborn, of the American Museum of Natural History, and Professor T. H. Morgan, of the California Institute of Technology.

DR. ISAIAH BOWMAN, director of the American Geographical Society of New York, was the recipient at Edinburgh on July 12 of the Livingstone gold medal of the Royal Scottish Geographical Society. This medal, which was instituted in 1901 by Mrs. Livingstone Bruce to commemorate her father, the great missionary-explorer, was awarded to Dr. Bowman "for his great services to geographical science."

THE council of the Royal Photographic Society has awarded the honorary fellowship of the society to E. J. Wall for outstanding achievements in photographic literature. The only other American honorary fellows are C. E. K. Mees, S. E. Sheppard and Alfred Stieglitz.

IN recognition of his "great public service from the standpoint of human values," and particularly for his "conspicuous work in the Mississippi flood relief," Herbert Hoover has been awarded for 1927 the Major Surgeon Louis Livingston Seaman medal by the American Museum of Safety. This medal is "for the best record in the saving of life in the field of sanitation and accidents."

THE Hector medal and prize of the New Zealand Institute for 1928 has been awarded, according to *Nature*, to Professor D. M. Y. Sommerville, of Victoria University College, Wellington, for his general mathematical work and for his investigations in non-Euclidian geometry. The medal is given yearly for distinction in different branches of science in rotation, in memory of the late Sir James Hector.

AT the summer graduation of the University of Aberdeen the honorary degree of LL.D. was conferred on Emeritus Professor J. D. MacWilliam, formerly Regius professor of physiology in the university.

ON the occasion of the celebration of the centenary of the faculty of medicine at the University of Sheffield, on July 11, the honorary degree of D.Sc. was conferred on Dr. Henry H. Dale, Professor A. J. Hall, Sir Frederick Gowland Hopkins and Sir Thomas Lewis.

AT the graduation ceremonial of the University of Edinburgh on June 28, the honorary degree of doctor of laws was conferred among others on Sir John Rose Bradford, president of the Royal College of Physicians, London; Professor F. G. Donnan, professor of general chemistry in the University of London; Professor J. Cossar Ewart, professor emeritus of natural history in the University of Edinburgh; Dr. R. A. Fleming, president of the Royal College of Physicians, Edinburgh; Dr. G. L. Gulland, professor emeritus of medicine in the University of Edinburgh; Mr. J. A. Hood, founder of the James A. Hood chair of mining in the University of Edinburgh, and Professor Niels Bohr, professor of theoretical physics at the University of Copenhagen.

DR. PAUL WALDEN, professor of chemistry in the University of Rostock, has been elected a foreign member of the Royal Academy of Sciences at Stockholm.

DR. ALFRED PHILIPPSON, professor of geography at the University of Bonn, has been elected an honorary member of the Royal Italian Geographical Society and of the Vienna Geographical Society.

Dr. Nicolle recently celebrated the twenty-fifth anniversary of his directorship of the Pasteur Institute of Tunis. On this occasion meetings were held in the municipal theater of Tunis.

Dr. Andrew Cowper Lawson, professor of geology and at one time dean of the college of mining of the University of California, retired on July 25, after thirty-eight years of service on the faculty. He becomes emeritus professor of geology and mineralogy.

Dr. Dexter S. Kimball, dean of the college of engineering of Cornell University, has been elected president of the Society for the Promotion of Engineering Education.

At the annual meeting of the American Society of Clinical Pathologists, held in Minneapolis, from June 8 to 11, Dr. Frank W. Hartman, Detroit, was elected *president;* Dr. James H. Black, Dallas, Texas, *president-elect;* Dr. Charles R. Drake, Minneapolis, *vice-president,* and Dr. Harry J. Corper, Denver, *secretary-treasurer.*

In addition to continuing his services as chief of the U. S. Bureau of Entomology, Dr. C. L. Marlatt has been designated chief of the plant quarantine and control administration, which was established on July 1. Mr. S. A. Rohwer has been designated assistant chief of this administration.

Stephen C. Simms, who has been a member of the scientific staff of the Field Museum of Natural History, Chicago, since it was founded in 1893, has been elected director of the museum, to take the place made vacant by the death of David C. Davies.

Blake R. Vanleer, assistant professor of mechanical engineering in the University of California, has been appointed assistant secretary of the American Engineering Council, succeeding A. C. Oliphant, who has resigned.

According to the *Journal of Terrestrial Magnetism* Antoni B. Dobrowolski, formerly vice-director of the Meteorological Institute of Poland, and Stefan Hlasek, formerly director of the Meteorological and Magnetical Observatory at Pavlovsk and of the Geophysical Observatory at Tiflis, have been appointed director and vice-director, respectively, of the Meteorological Institute of Poland. Dr. Gorczynski has retired from the directorship.

H. L. Mason, who has been connected with the teaching staff at Northwestern University, has accepted a position with the Mayo Foundation, Rochester, Minn., where he will be associated with E. C. Kendall.

Oliver C. Ralston, assistant chief metallurgist of the U. S. Bureau of Mines and supervising engineer of the Berkeley, Calif., Mining Experiment Station, has resigned to become director of research for the United Verde Copper Company, Clarkdale, Ariz., where a new research laboratory has been opened.

Dr. A. J. Stamm, colloid chemist on the staff of the U. S. Forest Products laboratory at the University of Wisconsin, has been granted a leave of absence to enable him to study under Professor Theodore Svedberg at Upsala, Sweden, as an International Education Board fellow.

The Secretary of Agriculture, W. M. Jardine, left Washington on July 27 for a three weeks' inspection tour of southeastern Alaska. He will sail from Seattle on August 7.

Commissioner O'Malley, of the U. S. Bureau of Fisheries, left Washington on June 15 for the Pacific coast, *en route* to Alaska, where he will devote attention particularly to measures in connection with the proper conservation of the fishery resources.

Dr. and Mrs. Herbert Spencer Dickey, who already have done much exploring in South America, sailed on August 1 for another expedition into the interior of South America, where they will study the nomadic Indian tribe known as the Piarroas. The party will be known as the Thea Heye-Dickey Expedition and will be under the auspices of the Museum of the American Indian, Heye Foundation.

After two and a half years spent in China, Sumatra, Java and Ceylon, P. H. Dorsett, of the U. S. Department of Agriculture, and his son have returned with a large collection of seeds, plants, bulbs and cuttings which may be useful in American agriculture.

The house at Poleymieux, near Lyons, France, in which Ampère spent his childhood and boyhood, has recently been acquired by the Société Française des Electriciens, which will maintain it as one of the historical buildings of France.

James Edgar Denton, professor emeritus of mechanical engineering at the Stevens Institute of Technology at Hoboken, N. J., died on July 17, aged seventy-three years.

George M. Beringer, a past president of the American Pharmaceutical Association, formerly editor of the *American Journal of Pharmacy* and chairman of the board of trustees of the Philadelphia College of Pharmacy, died on June 23, aged sixty-eight years.

Professor E. Wiechert, director of the Geophysical Institute and professor at the University of Göttingen, recently died, aged sixty-seven years.

The trustees of the Mount Desert Island Biological Laboratory have announced the following course of lectures to be given in the village church of Salisbury Cove at four o'clock: July 30, Dr. Warren K. Moorehead, of the Andover Museum, "Prehistoric Man in Maine"; August 9, Dr. George H. Parker, professor of zoology in Harvard University, "Color Changes in Animals"; August 15, Dr. S. A. Mitchell, director of the Leander McCormick Observatory, University of Virginia, "The Distances of the Stars"; August 20, Dr. E. G. Conklin, professor of zoology in Princeton University, "How can the Human Race be Improved?"; August 27, Dr. Ulric Dahlgren, professor of biology in Princeton University, "Luminous Animals"; September 3, Dr. Frank E. Lutz, curator of insects in the American Museum of Natural History, "Learning about Insects."

The Sigma Xi Club of the University of Florida presented the following program during the academic year of 1927–28: November 21, "Chlorophyll and Its Properties," from the viewpoint of the physicist, by Dr. J. R. Benton, the chemist, by Dr. R. C. Goodwin, the botanist, by Professor M. D. Cody, the geneticist, Dr. W. A. Carver, all from the University of Florida. December 8, "The Sidereal Heavens," by Dr. George H. Peters, U. S. Naval Observatory, Washington, D. C. January 18, "Soil Science from an International Viewpoint," by Dr. J. G. Lipman, director, New Jersey Experiment Station. March 6, "Biological Research in the Tropics," by Dr. Herbert Osborn, of Ohio State University, and "Some Interesting Plants in South Florida" by Dr. L. H. Pammel, of Ames, Iowa. May 16, "Recent Investigations in the Piezo-Electric Properties of Quartz Crystals," by Professor A. M. Skellett, of the University of Florida.

At the recent quarterly meeting of the council of the Royal College of Surgeons of England, Sir Berkeley Moynihan was reelected president, and Messrs. W. Hey Groves and V. Warren Low were elected vice-presidents for the ensuing collegiate year. Messrs. F. J. Steward, L. P. Gamgee, R. G. Hogarth and R. E. Kelly, newly-elected members of council, were introduced and took their seats. Mr. D. K. Cassels, who has been assistant to the secretary since 1924, was appointed assistant secretary to the college. The following Hunterian professors were elected for the ensuing year: Sir Arthur Keith, Messrs. Arthur H. Evans, G. E. Gask, C. A. Pannett, R. J. M. Love, C. P. G. Wakeley and R. T. Payne. Mr. Henry Albert Harris was elected Arris and Gale lecturer; Messrs. Thomas W. P. Lawrence and Clement E. Shattock were elected Erasmus Wilson lecturers, and Sir Arthur Keith was elected Arnott demonstrator for the ensuing year.

According to the *Electrical World* a party consisting of twelve French engineers interested in the production and transmission of electricity will leave Paris on September 12 for the purpose of inspecting the outstanding electrical installations of the United States. The party, which will arrive on September 18, will comprise Messrs. Girousse and Groslier, of the Northern Central Station Company of Paris, Lucien Feraud, director of the Northeastern Central Station Company of Paris, Georges-Bernard Dreyfus, managing director of the Eastern Distributing Company of Paris, Messrs. Lapeyre and Bres, Messrs. Maurice and François Fougerolles, of Fougerolles Brothers, M. Duval, chief engineer of the General Contracting Company, and Lucien Bourrellis, manager of the Central Station of Normandie. It is expected that the tour will require more than a month.

The *Electrical World* states that in view of the recent failures of some large dams with loss of life, the French government has sent invitations to the other governments of the world suggesting the desirability of the formation of an international commission of engineers to study the question of the safety and design of large dam structures. Spain, Roumania and Switzerland have already indorsed the suggestion and a committee has been appointed by the Union Internationale des Producteurs and Distributeurs d'Energie Electrique to make recommendations. It is expected that the American Society of Civil Engineers may act for the United States and that the entire question will act through the World Power Conference.

The Pan-American Medical Association, with headquarters in New York and chapter organizations throughout the principal cities of Latin-America, will hold its annual congress in Havana from December 29 to January 3. The oration in surgery will be made by Dr. William Mayo, of Rochester, Minnesota, and the oration in medicine by Professor Lewellys Barker, of the Johns Hopkins University. Dr. Damaso de Rivas, professor of tropical medicine at the University of Pennsylvania, will speak upon some phase of tropical disease. The president of the association is Dr. Fred H. Albee, professor of orthopedic surgery at the New York Post-Graduate Medical School.

An expedition into the little-known wilds of Papua, in southeastern New Guinea, to search for birds of paradise and other rare species, will leave early in August under the auspices of the New York Zoological Society. Lee S. Crandall, curator of birds at the zoological park, will lead the expedition. He will leave on board the steamship *Ventura,* of the Matson Line, for Sydney, Australia, where he will be joined by

J. E. Ward, an Australian naturalist. Together they will proceed northward 1,500 miles to Port Moresby, Papua, where the field expedition of carriers, interpreters and collectors will be organized.

Fifteen trained field workers from the department of geography at the University of Chicago, headed by Professor Robert S. Platt, left on July 26 for six weeks of field work in the heart of agricultural Mexico, to gather material for a book on "Occupancy Patterns of Population in Relation to the Natural Environment of the Valley of Mexico." The University of Chicago workers will analyze typical communities in the valley, particularly in the Teotihuecan district, and make a broad survey of the highland agricultural territory.

The acceptance of a deed to 12.6 acres of land for addition to the Aztec Ruin National Monument, northwestern New Mexico, and the issuance of a proclamation by President Coolidge adding this land to the monument and changing its name to Aztec Ruins National Monument were announced July 21 by the Department of the Interior. This additional land was donated to the government by the American Museum of Natural History to supplement a previous gift of the 4.6 acres of land constituting the original Aztec Ruin National Monument, which was reserved by presidential proclamation in 1923. The monument as originally established contained a single ruin which, because of its size and remarkable state of preservation, was an outstanding feature of the area. It is, however, an integral part of the cluster of ruins adjoining it on the land recently deeded to the government.

UNIVERSITY AND EDUCATIONAL NOTES

Dr. Charles L. Beach, president of Connecticut Agricultural College since 1908, was named president emeritus at a meeting of the board of trustees on July 18. Dr. Charles B. Gentry, dean of the division of teacher training and head of the department of education, was named acting president.

Dr. C. T. Dowell, who for the past eleven years has been on the faculty of Oklahoma A. and M. College at Stillwater, has been appointed dean of the school of agriculture and director of the experiment station at the Louisiana State University.

Dr. Arthur L. Tatum, associate professor of pharmacology at the University of Chicago, has been appointed professor of pharmacology at the University of Wisconsin.

Dr. J. P. Guilford, of the University of Kansas, has been appointed associate professor of psychology and director of the psychological laboratory of the University of Nebraska.

Dr. Charles Weiss, assistant professor of bacteriology at the school of tropical medicine of Columbia University and the University of Porto Rico, has been appointed associate professor of experimental bacteriology in the department of ophthalmology at Washington University, St. Louis. In collaboration with Dr. Harvey J. Howard, professor of ophthalmology in the university, he will be engaged in investigations on infectious diseases of the eye.

Herbert C. Tidwell, of Mexia, Texas, has been appointed assistant professor of chemical engineering at the Carnegie Institute of Technology for the year 1928–29. He will succeed Walter H. Taylor, who has been at the institute while on a year's leave of absence from the University of Shanghai.

Dr. C. H. Richardson, entomologist in the U. S. Bureau of Entomology, has been appointed associate professor of entomology at Iowa State College and assistant chief of the entomology section of the Agricultural Experiment Station.

Dr. Charles F. Roos has been appointed assistant professor of mathematics at Cornell University.

Dr. Boris Babkin has resigned from the chair of physiology at Dalhousie University, Halifax.

Dr. A. E. Cameron, professor of zoology in the University of Saskatchewan, has been appointed to succeed Dr. D. S. Patton in the lectureship in medical entomology, University of Edinburgh, Scotland.

Professor John McGibbon, professor of obstetrics in the University of the Witwatersrand, Johannesburg, has been appointed professor of midwifery and gynecology at the University of St. Andrews, in succession to Professor Kynoch, who recently resigned the chair.

Dr. Edward A. Milne, Beyer professor of applied mathematics at the University of Manchester, England, has been elected the first Rouse Ball professor of mathematics at the University of Oxford.

DISCUSSION AND CORRESPONDENCE

A PUZZLING BUTTERFLY MIGRATION

The fall migration of the Monarch butterfly, in great clouds, down the length of the Mississippi valley to the gulf is a well-established phenomenon. Records are accumulating that show a definite fall migration of the long-beaked butterfly from the plains of Texas south or southeast towards the gulf. A spring migration of the Painted Lady butterfly from Mexico northward into California in immense swarms has been recorded several times and seems to be established as a regular movement. These migrations are all of the same general character as the fall and

spring migrations of the birds and may well represent the same type of response.

The annual migrations of the Southern Cabbage butterfly (*Pieris monuste*) are, on the other hand, apparently just the reverse of this, as the immense swarms of this species travel southward down the east coast of Florida at the same time that the bobolink is leaving for the north.

The migration of the present season has been exceptionally heavy and has attracted a great deal of attention. Every automobile passing up or down the coast has emerged from the swarms with its radiator plastered with the butterflies, often to such an extent that heated engines were common and even bearings burned out. Stirling, in the *Florida Entomologist*, records a similarly heavy flight in 1923 and stated that it was an annual occurrence. Other observers have encountered these swarms every year since that time.

The present swarm was reported as between Jacksonville and St. Augustine on May 10. By May 20 it had moved more than one hundred miles south and at that time extended from New Smyrna to Ft. Pierce, a distance of one hundred and twenty-five miles. At present (June 20) the swarm is reported along the coast south of Miami, a movement of about two hundred miles in the month. On May 20 the writers drove through the swarm for eighty-five miles along the coast and then turned westward at right angles and drove thirty miles to Sanford. On the westward trip butterflies were counted crossing the road at the rate of six per mile or two hundred per hour. They were flying almost due south against a light breeze. In the first few miles from the coast the numbers were greater and they were flying southeast, swinging more to the east as they approached the coast. Along the shores of the Indian River they swung southward again, concentrating into a definite swarm only a few hundred yards in width and in passing obstructions narrowing to fifty yards or less. They were flying low, two to six or rarely eight feet in height and at the rate of six or eight miles per hour *against* a light wind. At Fort Pierce two hundred per minute were leaving a field one hundred yards wide. They flew about eight hours that day, which would give a total of one hundred thousand per day passing over an area that wide.

The writers observed that, although the swarm as a whole was moving down the shore, a constant procession of butterflies were striking out across the water to the southeast. Stirling records that from June 9 to 11, 1923, passengers on vessels plying between Nassau and the mainland observed millions of butterflies winging their way southward over the gulf stream. From these observations it would seem that the swarms noted along the coast are not continuously moving bodies but only a temporary piling up of individuals that are later to strike out over the water.

Where these butterflies come from and where they go are still mysteries but a still greater mystery is the force or impulse back of the movement that sends them in a reverse direction from ordinary migratory activity. Before we can hope to interpret this latter force we must have much more information as to the scope of the movement itself, and the present note is submitted in the hope that those who have further information will record it as soon as possible.

E. D. BALL,
W. E. STONE

ENTOMOLOGICAL LABORATORY,
SANFORD, FLA.

OBSERVATIONS ON PARTURITION IN THE OPOSSUM DIDELPHYS VIRGINIANA

IT was my good fortune, recently, to observe an opossum embryo during its migration from the vulva to the marsupium. Since, to date, there have been published only three accounts of the manner of birth of a marsupial it seems worth while to record these observations. The female opossum observed in this instance was of medium size and of a type popularly known to hunters as the "black-legged" opossum. She was captured near Charlottesville, Va., February 24, 1928, in a trap set beside the decaying carcass of a cat.

When I first saw her—at a distance of about fifty feet—she was sitting quietly by the trap watching me approach and made no move to escape or to "play 'possum," as these animals frequently do. On picking up the animal by the tail and releasing it from the trap, I noticed a greenish mucous discharge around the vulva. Further investigation revealed an embryo clinging to the mother's fur, having traversed about two thirds of the distance from the vulva to the opening of the pouch. I showed the animal to my wife, who also saw the wriggling bit of life making its way over a very difficult and treacherous trail. A few minutes later Mr. Paul R. Burch observed the foetus just entering the pouch. The entire interval from my first observation of the embryo until Mr. Burch and I watched it squirming its way into the pouch could not have exceeded twenty minutes. I feel sure that ten minutes is a more nearly accurate estimate. During all this time the mother was carried suspended by the tail and made no effort to aid the little one on its journey. Although I examined carefully the ground around the trap, I found no evidence that a foetus had failed to reach the pouch.

The movements of the opossum embryo are adequately described by Carl G. Hartman.[1] My observations, although more limited, corroborate his account of the birth of the opossum's young. It is an interesting point to note that in this instance the hind limbs of the foetus were comparatively inactive.

There were thirteen young in the pouch of this animal. Dr. H. E. Jordan determined the greatest length (in this instance the vertex-breech distance) of seven of the embryos to be as follows:

Number of embryos	Greatest length
2	10 mm
2	11 "
1	11.5 "
2	12 "

L. M. Dickerson

Miller School of Biology and the Blandy Experimental Farm, University of Virginia

A NEW RHIZOPUS ROT OF RUTABAGA

In November, 1927, the junior author found in one of the Evanston fruit and vegetable stores a number of bushels of rutabagas heavily infected with Rhizopus. The rot produced is a typical wet rot such as is produced by other species of Rhizopus, but it works slowly as compared with *Rhizopus nigricans* Ehrb. For example, where *R. nigricans* produces a wet rot in three days, the new Rhizopus requires six days. Inoculation experiments have shown the latter to produce a typical rot in carrot, cucumber, eggplant, green pepper, Hubbard squash, onion, pumpkin, sweet-potato and tomato.

The fungus, when studied in pure culture, proved to be an undescribed species and for it the name *Rhizopus fusiformis* sp. nov. is proposed.

Rhizopus fusiformis sp. nov.

Forming on bread at first a white, cottony mycelium, becoming in age a loose, light gray turf 0.5–1.5 cm high. Sporangiophores 1–2 mm tall, 13.5–17 μ in diameter, trailing, irregularly branched in umbels of two to six sporangiophores, sometimes again branched with a fusiform swelling immediately below the insertion of the branches, some of which may end in sporangia. Sporangia but sparsely developed, globose, 70–113 μ in diameter, with deliquescent wall. Columella spherical, 30–65 μ in diameter. Spores angularly subglobose to suboval, pale gray, smooth, 5–7 x 3.5–7 μ. Zygospores not found.

Isolated from rutabagas rotting in an Evanston store.

Rhizopus fusiformis Dawson and Povah is characterized by its cottony mycelium, its sparse production of sporangia and its branched sporangiophores with a fusiform swelling at the base of the insertion of the branches. It resembles *R. nodosus* Namysl. in the production of swellings on the mycelium, but differs from it in the shape and location of the swellings. In the mode of branching, it recalls *R. arrhizus* Fischer, but differs from it in the size of the sporangia and the production of swellings.

Marion L. Dawson
Alfred H. Povah

Northwestern University,
Evanston, Illinois

WHAT DRAWS MEN INTO GEOLOGY?

Dr. George H. Ashley,[1] in discussing the present standing of geology, writes, "To the world at large, geology has taken a back seat." The remedy he proposes is largely that of presenting geology in a more popular and palatable form to the general public. This is a most desirable aim; but, to the writer, another serious phase of the problem is to attract to geology the ablest type of student. Recently, the late Professor Nathaniel Shaler's course in geology at Harvard has been cited, by a leading educator of Columbia University, as an example of what an "easy" course might lead to in attracting large numbers of students and in stimulating many able men to take up geology as their life work. Professor Shaler's enthusiasm certainly must have been contagious and his lectures stimulating. But were there not external cooperating factors to aid at that time in producing professional geologists? As Dr. Ashley has pointed out,

> The average man of culture fifty years ago had a better knowledge of these things (geological concepts) than the man of culture to-day. . . . We were a new country, and the men who explored this new country and told us of its mineral wealth loomed large in public affairs.

The United States Geological Survey, which dates its period of greatest growth from that time, then afforded opportunity for the employment and training of geologists and created a demand for them.

At the present time the University of British Columbia has an outstanding record in North America for the number of its graduates who have proceeded to advanced work in geology during the last few years. At my request, Dr. S. J. Schofield furnished me with a list of them, which shows that during the last six years twenty-seven graduates of British Co-

[1] *Anatomical Record*, Vol. 19, 1920, p. 256.

[1] "Geology and the World at Large." Address of the vice-president and chairman of Section G—Geology, American Association for the Advancement of Science, Nashville, 1927. Science, Vol. lxvii, 1928, pp. 22–24.

lumbia have taken or are taking graduate work in geology, and that twenty-three of these have taken or are studying for the doctor's degree in geology. In order to ascertain the causes of this success, I asked a number of these men how they explained it, and their answers are summarized herewith:

(1) Environment is an important factor. British Columbia is still largely in a pioneer state, with great undeveloped mineral resources, and a consequent respect in the community for the geologist. It is a mountainous country, with a corresponding attraction for youth. As one man expressed it, "The rising generation grasps more readily at a prospecting pick than a brief case, and leans more towards a transit than a golf club; there is an appeal to romp over the rugged peaks of the Cordillera, rather than languish on the office stool." The attractions of business are not so prominent or so omnipresent there as they are in some parts of the United States.

(2) The geological faculty comprises a strong and inspiring group of men, who emphasize the high standing of the profession, the ability of the pioneer Canadian geologists and the necessity for a thorough training for those who would follow in their footsteps.

(3) An unusually good opportunity is afforded of doing summer work and getting field training; because of the exceptionally enlightened policy of the Canadian Geological Survey, whereby the most able students are selected for field assistants to geological parties, every effort is made to further their education and to afford field work suitable for doctorate theses, and publication of satisfactory theses is assured.

(4) There are good opportunities for positions with the Canadian Geological Survey, with universities or with mining companies, after completion of training.

I believe that there is more interest in geology in general in the Canadian universities than in those of the United States, due to the combination of these factors. The existence, popularity or stimulus of an "easy" course, as such, is not a vital factor but a mere incident drawing men into geology. To judge from the number of popular books on geology which are being written and the number of summer schools and summer tours in geology which are springing up on every side, the universities recognize the desirability of popularizing geology, and the geological faculties are aiming to supply the needs of the amateur in different ways.

But for the potential professional geologist, the opportunities for the long period of systematic training in field work, so necessary to his education, are meager, for the expense is beyond the means of most of such students. This is the serious problem. A revival of the state geological surveys and a definite recognized system for aiding men in getting their field training by such surveys and by the U. S. Geological Survey, would, I believe, attract more able men into the profession and produce better trained geologists.

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THE EARLIEST DYNAMO

H. W. Wiley, in your issue of May 25, quite correctly calls attention to the fact that the fiftieth anniversary of the dynamo should have been held some time ago and speaks of two French dynamos exhibited at the Centennial exposition in 1876. The earliest dynamo made in America, constructed before the importation of any machines from Europe, was exhibited and operated at the same exhibition. It is referred to in the biography of John E. Sweet (published by the American Society of Mechanical Engineers) as follows:

> At the exhibition the engine [a twenty-horse power engine designed by Sweet] drove an electric-generating machine, the first to be constructed in the United States, which supplied electrical energy to a single arc lamp, one of the very earliest of its kind. This exhibit attracted wondering attention; but those who saw it considered it as an interesting toy and probably had no conception of the future of electric lighting and power development. The electric generator or "Gramme machine" was built under the direction of Professor William A. Anthony, with the cooperation of Professor Sweet and Professor Moler and the students of Sibley College [of Cornell University], after the design of M. Gramme, of Paris, which was illustrated and described in London Engineering, August 4, 1871 . . . March 14 and April 25, 1873.

This dynamo delivered 20 amperes and 150 volts. It was used to operate two arc lights on the Cornell University campus. The arc light had previously been used in European lighthouses, but this was probably the first instance of outdoor electric lighting, certainly the first electric lighting in America. The machine was again exhibited at the Louisiana Purchase Exposition in 1904, where it was awarded a medal as the first dynamo in America. The machine is still in good condition.

Frederick Bedell

THE MEASUREMENT OF ULTRA-VIOLET RAYS

In the issue of Science for May 11, 1928, No. 1741, in the section "Science News" there is a report entitled "The Measurement of Ultra-Violet Rays." It is intimated that Dr. E. A. Pohle, of the University of Michigan, together with several coworkers, has designed a device for the measurement of ultra-violet rays, which consists of a cadmium photoelectric cell

in connection with a radio amplification circuit. It would appear from this article that this measuring device is original with them.

The cadmium photoelectric cell has been used by Prof. Dorno-Davos since 1914 for the measurement of ultra-violet rays and he especially recommends it in medical practice, since its sensitivity towards different parts of the ultra-violet spectrum is parallel to that of the human skin. Dorno also was the first to suggest an ultra-violet unit based on this cell and to calibrate practical instruments.

The amplification of a small current of a photoelectric cell by a radio amplifier was made as early as 1919 by C. E. Pike, who published his arrangement in *Physical Review*, 13, 102. Many others, such as H. Rosenberg (*Die Naturwissenschaften*, 1921, Heft 19/20), Abraham and Bloch (Comptes Ren., 1919, 168, 1321), E. Meyer and R. Tank, have described such circuits. Practical instruments using such circuits to amplify the small current produced in ionization chambers employed in radiation therapy as well as that of photoelectric cells have been on the market for a number of years and are widely used by the medical profession in this country and abroad. Simple arrangements using the Dorno cadmium cell in connection with the electroscope have been especially designed for the medical profession and have been also on the market for quite some time. There have been a number of publications on the results obtained.

OTTO GLASSER

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NUCLEAR AND DIFFERENTIAL TISSUE STAIN COMBINED

IN the teaching of histology I have always felt that the practical recognition of tissues under the microscope can not be too strongly stressed. With this thought before me I began experimenting with various stains and combinations of stains in an attempt to strike a method that would differentiate tissues and at the same time bring out the structure of the nuclei. After several years of such experimentation I believe that I now have struck a combination stain that will differentiate the nuclei as well as the tissues.

In writing up my staining method for SCIENCE I claim absolutely no credit for a new stain. The only newness in my staining method is the manner of combining and manipulating two old stains, namely, Delafield's hematoxylin and Mallory's connective tissue stain. The successive steps in my staining method follow:

(1) Stain sections in Delafield's hematoxylin for five minutes.

(2) Pass through distilled water to remove excess stain.

(3) Stain in 0.2 per cent. aqueous solution of Acid Fuchsin for one minute.

(4) Pass through distilled water to remove excess stain.

(5) Stain in the following solution for two to three hours:

Anilin blue (water soluble)	0.5 gm.
Orange G	2.0 gm.
Phosphomolybdic Acid	
(1 per cent. aqueous solution)	100.0 cc.

(6) Pass through distilled water to remove excess stain.

(7) Pass successively (rapidly) through the following grades of alcohol: 35 per cent., 70 per cent. and 95 per cent.

(8) Complete dehydration in absolute alcohol in one-half to one minute. (Water-free acetone may be used in place of the absolute alcohol, with but little or no shrinkage of the cells.)

(9) Clear in xylol.

(10) Mount with cover-glass.

With this stain nuclei will appear a rich red, epithelial cells pink, connective tissue blue, and muscle red. Red blood cells will stain yellowish in veins, reddish in arteries. Colloid and mucus stain blue. Sections stained by this method more than five years ago have not faded. The staining seems to follow any fixation well. The hematoxylin penetrates the nuclei; then the acid fuchsin changes the hematoxylin over to a red color and perhaps aids in intensifying this red. This is my explanation why I get better nuclear differentiation with this method than I do with Mallory's stain alone. As to this I ask others to check me up.

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WATERING POTTED SOIL KEPT UNDER MICROBIOLOGICALLY CONTROLLED CONDITIONS[1]

NUMEROUS forms of apparatus have been devised for growing plants under microbiologically controlled conditions. The issue of SCIENCE for March 30 last contained an apparatus used at Amherst. The pamphlet of Klein and Kisser[2] contains twenty diagrams.

[1] Approved as Scientific Paper No. 55 by the director of West Virginia Agricultural Experiment Station, Morgantown, W. Va.

[2] Klein, G., and J. Kisser, "Die Sterile Kultur der Höheren Pflanzen." Botanische Abhandlungen, Heft 2, 1924.

However, when it was desirable to have some four-gallon pots of soil in which plants could be grown under controlled conditions, several difficulties had to be overcome. The use of Livingston's auto-irrigator cones for supplying water in other pot work[3] suggested the idea that internal watering would be ideal for watering controlled cultures. When soil in large pots is to be used, some method must be found to cover the soil with a cotton seal that will not be wetted by the moist soil. This has been accomplished by placing an inch mulch of very coarse gravel over the soil. Various pieces of apparatus have been devised to work a cotton seal around the stem of a sterile seedling. A number of these are suitable. It has been found that the double cylinder described by Fred[4] can easily be inserted in the large cotton seal covering the pot.

A more complete description of this apparatus appears in the June issue (Vol. 20, No. 6) of the *Journal* of the American Society of Agronomy.

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SPECIAL ARTICLES

THE EFFECTS OF RADIUM IN PRODUCING LETHAL MUTATIONS IN DROSOPHILA MELANOGASTER

Muller's[1] recent discovery that X-rays produce gene mutations in fruit flies is one of the most notable events in the field of pure biology in this century.

The experimental modification of the germ-plasm is an old problem. Many investigators have tried their hands at it. All sorts of chemical and physical agents: serums, high and low temperatures, alcohol, continuous and intermittent rotation, ultra-violet light and probably other agents have been imposed upon different species of organisms. But the genes remained stable.

In an attempt to alter the genes in the albino rat the authors administered alcohol fumes daily to ten successive generations of rats. Treatment was begun at twenty days of age and continued until the animals were fully adult. The soma cells were badly injured: nearly all the individuals were rendered blind, they were stunted in growth, hair development was interfered with and numerous other evidences of degeneration appeared. But all these were merely somatic changes. The genes would not play fair. They took the alcohol but refused to alter. The young of ten generations of alcoholic ancestors were both physically and mentally the equals of the controls and in some cases slightly superior. This has been the common experience of all who have tried to modify the gene constitution of either plants or animals.

Now comes the change. The treatment of fruit flies with X-rays brings gene mutations in such bewildering rapidity that it is impossible to breed and study them all. In some of Muller's experiments the rate of mutation among progeny of irradiated parents was 15,000 per cent. greater than among the controls. On one Sunday afternoon forty mutations were found. Prior to the use of the X-ray, if one mutation were found in forty Sunday afternoons the time would have been considered well spent.

Radium is as effective as X-rays in causing mutations and in certain respects has advantages over the latter. Two of these advantages are: (1) Ease of controlling and repeating exact dosages, and (2) the possibility of separating the different rays involved to determine which ones are effective in altering the gene.

Experiment I. Wild type males were exposed to 150 milligrams of radium for six hours.[2] The flies were confined in shell vials $2\frac{1}{2} \times 1$ inches. The vials contained one inch of cooked banana-agar food, and the open ends were covered with two layers of gauze. The radium needles were attached with adhesive tape to the gauze.

Immediately following treatment these males were mated, in pairs, to females having the genes for scute (sc), vermilion (v), forked (f), and bobbed (bb) in one X-chromosome and a gene (C) to prevent crossing over, a lethal gene (1), and the bar gene (B) in the other X-chromosome. The F_1 females were of two classes, bar and not-bar. The bar-eyed females were mated to their brothers, one pair to a tube, to produce the F_2 generation. Due to the presence of the lethal gene half the sons in this generation are killed. If a new lethal mutation arose as the result of the radium treatment the other half of the sons would inherit it and not appear. Hence no males would hatch in that particular tube. To determine the number of lethal mutations occurring as a result of the radium treatment it was only necessary to count the number of tubes in which there were one hundred per cent. females.

The numbers in the first experiment were too small to give a reliable percentage of mutation. There

[3] Deatrick, E. P., "Porous Clay Auto-irrigator Cones for Watering Potted Soil and Plants," Jour. Amer. Soc. Agron., 19, 252–255, 1927.

[4] Fred, E. B., "Laboratory Manual of Soil Bacteriology," p. 161.

[1] Muller, H. J., 1927, "Artificial Transmutation of the Gene," Science, 66: 84–87.

[2] The radium used in these experiments was loaned by the Barnard Free Skin and Cancer Hospital in St. Louis. Our appreciation of this courtesy is hereby expressed.

were one hundred and ten tubes of controls and thirty-one tubes of the treated. No mutations occurred in the controls, while four out of the thirty-one treated tubes showed lethal mutations. This is a mutation rate of 12.9 per cent. While numbers so small as these may have little value in themselves they pointed the direction for further work.

Experiment II. This experiment was an exact repetition of the first one, with the addition of a group in which gamma rays only were permitted to reach the flies during treatment. This was accomplished by enclosing the glass vial containing the flies in a cylinder of soft lead. The lead in this cylinder was two millimeters thick and effectively stopped both the alpha and beta rays. Since it also reduced the amount of gamma rays the time of treatment was extended from six to thirteen hours.

The following table gives the results of the second experiment. In the column marked "dosage" it will be noted that 140 milligrams of radium were used instead of the usual 150 milligrams, one ten mg. needle not being available at that particular time.

	Dosage	Number F_2 tubes	Number lethal mutations	Percentage of mutation
Control	———	423	0	0
Radium	140 mg. radium 6 hours	426	35	8.2
Gamma rays only	150 mg. radium 13 hours	426	12	2.8

Five hundred tubes each of controls, "all radium" and "gamma only," were made up. All sterile tubes were eliminated from the experiment, so the numbers in column 3 of the table represent fertile pairs.

In the "all radium" group the mutation rate is 8.2 per cent., while in the first experiment it was 12.9 per cent. The reasons for this difference are at least two: first, there were ten milligrams less of radium and, second, the difference in size between the two samples, thirty-one tubes in the first experiment and 426 in the second, might well give a difference as great as this. There is a striking difference between the rate of mutation in the "all radium" group (8.2) and the "gamma only" group (2.8). This may be due to the fact that the beta rays are also effective in causing mutations, or, as we have learned since, the time was not sufficiently extended to give the same amount of gamma radiation as in the "all radium" group. More probably both factors were responsible for the difference.

As the results stand now the two experiments show that radium emanations produce lethal mutations in Drosophila and that gamma rays alone will also do the same thing. This is the first step in the analysis of just what elements in radium and X-rays are responsible for the results obtained. Further work on the analysis of the three rays of radium is now under way.

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THE NATURE OF THE ACIDIC SUBSTANCE FORMED ON THE HYDROLYSIS OF ACACIA

DURING the course of a study of the acid polysaccharides occurring in plants, we have had occasion to devote considerable time to the chemistry of acacia or gum arabic.

The plant gums, as is well known, are salts of very complex organic acids, usually with calcium, magnesium and potassium. These complex acids are built up of hexose, pentose and methyl pentose units in combination with the acidic part of the molecule. Many gums liberate carbon dioxide on heating with 12 per cent. hydrochloric acid,[1] and they give the naphtho-resorcin test.[2] It is therefore believed that they contain *uronic* acid units.[3]

But little work has been done on the acidic nucleus of gums since the researches of O'Sullivan.[4] This author found that arabic acid—from gum arabic—on heating with dilute sulphuric acid yielded an acid of lower molecular weight which he called λ-arabinosic acid and which was stable enough to resist the action of 3 to 4 per cent. sulphuric acid—at 100°—for several hours. He assigned to the substance the formula $C_{23}H_{38}O_{22}$ from the results of the analysis of its barium salt.

We have planned to make an extensive study of gum arabic in this laboratory, and as a part of our program have submitted a botanically authentic sample of the gum to hydrolysis with dilute sulphuric acid under much the same conditions as those employed by O'Sullivan.

The acidic product of the hydrolysis appears to be identical with the λ-arabinosic acid of the earlier investigator. The substance has been isolated and analyzed in the form of its calcium salt. The analytical

[1] Nanji, Patton, Ling, *J. Soc. Chem. Ind.*, 44, 253T (1925); Anderson and Sands, *J. Am. Chem. Soc.*, 48, 3172 (1926).

[2] Tollens, Ber. 41, 1788 (1908).

[3] Widsoe and Tollens, Ber. 33, 132 (1900); see also ref. (1).

[4] *J. Chem. Soc.*, 45, 41 (1884); *ibid.*, 59, 1029 (1891); *ibid.*, 79, 1164 (1901).

gures indicate an aldobionic acid of formula $_{12}H_{20}O_{12}$. In fact O'Sullivan's analytical data gree better with the requirements of the barium salt f an aldobionic acid than with the barium salt of a ibasic acid of formula $C_{23}H_{38}O_{22}$. It gives a strong aphtho-resorcin test and reduces Fehling's solution igorously. On boiling with 12 per cent. hydrochloric cid, the correct amount of carbon dioxide is liberated nd the glucose value, calculated from the amount of odine consumed in oxidation, as well as the percentge of calcium found, corresponds to the requirements f a compound of formula $C_{12}H_{20}O_{12}$ containing one ldehyde and one carboxyl group.

Aldobionic acids are substances new to chemistry, nd to date have been found only in the soluble immune substances produced by bacteria, *e.g.*, pneumococcus Types II and III, and by Friedlander's acillus,[5] Types A, B and C.

It has been said that true gums are never formed xcept by the decomposition of vegetable tissue due o a diseased condition of the plant. Some authoriies have claimed that this morbid process is the reult of bacterial action,[6] and, if this is true, it is not urprising that an aldobionic acid would be found. We have not as yet identified either the uronic acid r the sugar component of this aldobionic acid, but are t present engaged in the solution of the problem.

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VARIETY OF BEHAVIOR OF LARVAL TREMATODES

THE life cycle of most trematode parasites includes two free-swimming stages: the miracidium and the cercaria. The mature worm, parasitic with few exceptions in a vertebrate, produces eggs which develop into miracidia; these hatch out in water and then penetrate an invertebrate intermediate host, which is almost always a gastropod mollusk. From the point of entry the miracidium usually makes its way to, and lodges in, the hepato-pancreas or the gonad; here it metamorphoses into a sporocyst, the first of a series of parthenogenetic reproductive stages (daughter sporocysts or rediae or both) the last of which finally produces in large numbers a larva known as a *cercaria.* The cercaria of most species deserts the mollusk host and has a period of free-swimming existence which lasts at most several days. The tail of the cercaria, in many cases a highly modified larval swimming organ, is cast off at the beginning of postlarval development, when the cercaria penetrates the body of an intermediate invertebrate host, or, in a few species, the definitive vertebrate host.

The morphology of a great many cercariae has been more or less completely described, but no detailed studies have been made of their behavior, which is varied and is of interest from a number of standpoints. Observations and preliminary experiments made by the author on representatives of various groups of cercariae, chiefly fresh-water ones, from Illinois, Michigan, Missouri, Washington, and from Woods Hole and the Dry Tortugas justify the expectation that larval trematodes are an important source of experimental material, especially for a study of the responses of animals to changes of light intensity.

In so far as these larvae have been studied it has been found that the swimming behavior of each species is distinctive; the only time that preliminary observations failed to show differences between species was in the case of two which have only slight morphological differences. In most cases examination of living cercariae with the unaided eye, or with a hand lens, is sufficient to distinguish among the species found in a locality; but it is not true that species of furcocercous cercariae with long furcae may be thus differentiated, except by closer examination. From the standpoint of the parasitologist it will be interesting to determine in what ways the swimming behavior and the responses to stimuli normally encountered in nature play a rôle in the life history of the species.

Unstimulated swimming behavior. Locomotion is effected principally by vigorous movements of the extensile and usually very muscular tail. Some species swim almost, if not quite, incessantly from the moment of liberation from the host; but the greater number are intermittent swimmers. Among the species in either group considerable variations occur in swimming behavior. Some of these are described in this paper.

Among the *incessant* swimmers the individuals of one species swim close to the surface of the water with rapid and sudden changes of direction, while those of another species swim erratically throughout the container; in some species locomotion is very slow. The individuals of a few species aggregate in the most illuminated part of the container. In the *intermittent* swimmers a period of passive sinking alternates with a period of locomotion upward, usually in a more or less vertical path. During the period of passive sinking the individuals of most species are motionless, or almost entirely so; the length of this period gradually increases until finally the cercariae come to rest on the bottom. From this position, or during the period of sinking, they may suddenly swim

[5] Heidelberger and Goebel, *J. Biol. Chem.*, 74, 613 (1927); *ibid.*, 74, 619.

[6] G. Smith, *J. Soc. Chem. Ind.*, 23, 972 (1904).

upward, and then at times downward, or they may suddenly and erratically change the direction of their path. The rate of locomotion may be slow, but in most species it is relatively rapid.

In many species in which the cercariae are motionless during sinking or after they are at rest on the bottom, the form of the body and tail is characteristic of the species; many different shapes are assumed by the individuals of different species. At the moment of coming to rest the axis of the body may be at any angle with the horizontal; in one species the cercariae very quickly orient in a vertical position with the body down, while all individuals of another species may very slowly become thus oriented, or may sink in the chance position in which they came to rest. These variations are due to differences in the specific gravity of body and tail. Some species of cercariae swim with the tail directed forward and others with the body in advance; the former is the more common method. In a few species of furcocercous cercariae there may be a reversal of direction without any apparent change in the character of the rapid movements causing the locomotion.

Reactions to mechanical stimuli. To a stimulus occasioned by jarring the container, or by the touch of an instrument or of a swimming individual, some species of cercariae at rest immediately respond by swimming upward. In the case of others a short reaction time[1] intervenes between stimulus and response. In contrast with these, the individuals of some species while sinking may be vigorously struck by an instrument without causing them to resume locomotion or to change their characteristic shape.

Reactions to light. Cercariae of some species are strongly photopositive or photonegative, aggregating in the most highly illuminated or in the least illuminated regions of the container and returning rapidly to these regions when the container is turned. The individuals of other species aggregate less closely and return much less rapidly when the container is rotated. However, it is not this type of reaction but the variety of response exhibited by different species to change of light intensity, which is the most interesting aspect of the behavior of larval trematodes.

Reaction to decreased light intensity. In the case of larvae which swim intermittently a number of species have been found in which a shadow falling on cercariae, either while sinking or while lying motionless on the bottom of the container, results in their activation; in most cases an immediate response occurs, but in one among five species observed there was a reaction time of about five seconds (aver.).

[1] The time from the application of the stimulus to the beginning of the response.

The response in either case is a resumption of locomotion, usually an upward swim. In other species larvae at rest are not stimulated to swim by a decreased intensity of light: but those which are swimming suddenly stop, either immediately or at the end of a very short reaction time.

Only one of the few species of incessant swimmers observed reacted noticeably to a shadow; in this case a reaction time intervened between stimulus and response (about two seconds) during which all cercariae continued in locomotion and at the end of which they more or less concertedly stopped, and then sank. At the end of a period of inactivity, which lasted about as long as the reaction time, normal locomotion was resumed.

Reaction to increased light intensity. An increased intensity of light falling on intermittent swimmers during the interval of rest (sinking or on the bottom of the container) results, in most species, in the activation of the cercariae; in most species there is a definite reaction time preceding this response, which is usually an upward swim. Cercariae which are incessant swimmers are apparently not affected by an increased light intensity.

Reaction both to decreased and to increased intensity of light. Some species of intermittent swimmers, stimulated while at rest, respond by swimming upward either when the light is suddenly decreased or when it is increased. The individuals of one of these species respond immediately to a decreased light intensity (shadow); and if the shadow remains on the cercariae for less than three seconds there is also a response to the increased light intensity caused by the sudden removal of the shadow.

Although experiments have so far been largely of a preliminary nature it is thought worth while to call attention to this important source of material, especially for the study of the reactions to light. Cercariae in many ways constitute ideal material for such an experimental study. The molluscan fauna of the United States is very rich, and large numbers of cercariae may usually be obtained from a single infested snail host. They emerge from the snail and may continue to be liberated daily. These emerged larvae are all fully developed, and it is assumed that they are very nearly of the same age. During their brief free-swimming existence, usually of not more than 48 hours duration, they do not eat and hence the food factor does not enter into their behavior. For these reasons it is thought that cercariae constitute material that is at least as uniform as any which has been used for behavior studies.

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